GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF PUBLIC INSTRUCTION
BUREAU OF AGRICULTURE

F. W. TAYLOR, DIRECTOR OF AGRICULTURE

BULLETIN NO. 25

The Philippine Coconut Industry

BY

O. W. BARRETT
Chief, Division of Horticulture

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THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF PUBLIC INSTRUCTION
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TYPICAL COCONUT RAFT, PAGSANJAN RIVER, LAGUNA.

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MANILA, *January 18, 1913.*

SIR: I have the honor to transmit herewith, and to recommend for publication as a bulletin of the Bureau of Agriculture, manuscript entitled "The Philippine Coconut Industry."

In this manuscript have been included most of the ideas which were embodied in Bulletin No. 17, "Coconut Culture," and in the Coconut Number of the Philippine Agricultural Review for May, 1912, together with considerable later information regarding cultural methods, statistics, and management of coconut plantations.

Very respectfully,

O. W. BARRETT,
Chief, Division of Horticulture.

Mr. F. W. TAYLOR,
Director of Agriculture, Manila, P. I.

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Publication authorized:
NEWTON W. GILBERT,
Secretary of Public Instruction.

THE PHILIPPINE COCONUT INDUSTRY.

FOREWORD.

The world's most important food fruit is the coconut; the grape and coffee are more important only in commerce. It is only within the last fifteen years, however, that the commercial interests have realized that in the oil obtained by pressing copra, the dried "meat" of the coconut, there is not only a very cheap source of vegetable fats—both tallows and oils—but several kinds of wholesome human food as well. From all indications it will be many years before chemists can produce cheaply from synthetic operations any substances which might take the place of the vegetable oils. Such oils are safe, therefore, from the attacks, so to speak, of synthetic scientists.

Most oils contain a certain amount of acid which is more or less irritating to animal tissues and even slightly injurious to metals. On that account certain oils can not be used either as human foods or as lubricating media without expensive purifying processes. It follows then that an oil such as that from copra, carrying practically no injurious acids nor substances which in any way attack either tissues or metals, is, and for a long time will be, a highly important factor in the world's commerce.

In the Philippines the coconut crop has been handled until the last few years in a very desultory, not to say reprehensible, manner; the export of copra began to assume importance about 1890. The old plantations contain at least 30, and some even 300 per cent, too many trees for the best results to be obtained, and only a comparatively few young plantations in the hands of American or foreign capitalists are correctly set out and properly cultivated. Besides the glaringly wrong system of close planting noticeable in practically every one of the Filipino plantations, there has been another feature or perhaps no less weight in determining the yield of the trees—lack of cultivation and especially lack of attention to the young palms. It is a well-known fact that neither orchard fruit trees nor even coconuts grow rapidly or healthily when grass is allowed to cover the crop-tree roots; this fact will be explained in the chapter on soils and locations.

Through this deplorable lack of attention to the young trees in particular, and to the older groves in general, the age at which a paying crop of nuts is obtained may be deferred from three to even ten years beyond the due time. Numerous cases, however, are reported of four-year-old trees bearing fruits. Ordinarily with even moderate attention a fair number of nuts should be matured before the seventh year from setting out, and barring disasters, if no crop is secured by the eighth year there is certainly something radically wrong either with the location or with the management of the plantation.

The outlook for splendid profits from the coconut crop in the Philippines is unquestionably good; in fact, there is probably no other crop having such possibilities, with the exception, perhaps, of sugar cane, and none which has such a bright future before it. To be sure, abacá, or "Manila hemp," if the present high prices continue, will remain fairly profitable in several provinces, at least until the numerous large sisal plantations come into full production. The price of copra has fluctuated considerably during the last decade but on the whole is gradually increasing; the fluctuations depend partly upon commercial vicissitudes but largely upon local damages to the source of supply, such as drought, typhoons, etc., in Malaysia, Ceylon, the Philippines, and the Pacific archipelagos.

The coconut as a crop plant stands in a class by itself. While requiring certain lines of treatment for the fullest success there is really no feature about it which can be called difficult for even the inexperienced planter; in fact, there are few tropical crops which require less skill, capital, or attention, or whose gross culture is less expensive. This point, however, in a way has militated against highly profitable coconut planting, the old idea seeming to have been that the coconut could and should take care of itself, the only action on the planter's part being to put the seed or young palm into or onto the earth and to collect the fallen nuts in due course—or, if in a hurry to fill an order (sic), to climb the trunk and pick them.

No accurate data as to the number of coconut trees in the world's plantations are available, but it is fairly certain that the figure should be something above 300 millions. The copra in commerce, however, amounts to scarcely one-third of what might be expected, only some 600,000 to 700,000 tons (a little over 10 million piculs), worth to the producers about 125 million pesos (say, 65 million dollars gold); this is, of course, exclusive of the *local food* nuts which are probably worth from 75 to 100 million pesos to the local inhabitants. If *all* the coconut trees of the world gave 40 nuts apiece we would have the tremendous

crop of 10 billion nuts per year, or well over 300 nuts per second—which, if laid end to end, would form a line reaching around the earth 90 times, which would make a broad belt some 20 meters (65 feet) wide for a boulevard over land and sea.

At present the Philippines are producing something like 175,000 tons, or about one-fourth of the world's total copra output; this, the second Philippine crop in export importance, is worth locally nearly 30 million pesos (15 million dollars gold.) A very severe drought and more or less typhoon damage in certain provinces may slightly reduce this figure for the fiscal year 1913. It is expected that the copra shipments from the Philippines will continue to increase at the rate of from 15 to 20 per cent per annum for a goodly number of years to come. The copra export value for 1912 (fiscal year) was 46 per cent greater than in 1911.

The number of bearing trees is now about 30 millions and of immature trees about 20 millions. These occupy about 200,000 hectares (half a million acres).

Both Java and the Malay States are rapidly increasing their copra production and may closely rival the Philippines in the amount exported. Ceylon has some 60 million trees and could, if the price were sufficiently attractive, export a very much larger quantity of copra than is now the case; it appears there is an almost unbelievably large number (some 1½ millions *per day*) of coconuts used as food by the peoples of that island, and from some statistics it would look as if fully one-half of the total number of nuts produced in Ceylon are consumed as human food. Broadly considered, it is probable that hardly one-third of the world's coconuts are made into copra. Of the many millions of nuts produced in tropical America all but about 1 per cent are used fresh.

In the Federated Malay States coconut planting is proceeding at a remarkable rate. Notwithstanding the fact that certain areas have given phenomenally good returns in "Pará," we occasionally come across written opinions to the effect that coconuts are "more sure than rubber." Recent reports from Papua, the Solomons, and the New Hebrides indicate that coconut planting has come to stay in that section of the world, and with European capital behind these large and well-managed estates there is not much doubt that even with a precarious labor supply and a large list of insect enemies the commercial world will soon hear a great deal about copra from that new region, which until a few years ago was considered about the uttermost end of the earth, agronomically and otherwise speaking.

Africa may eventually become a great copra-producing conti-

nent but thus far the comparatively small plantations along the East Coast do not affect the world's market; two of the coconut's oil-market rivals, the oil palm and the peanut, are, however, much in evidence there, especially on the West Coast. The Pacific archipelagos will probably not be able to produce very much more copra than they have been turning out for the last ten or twenty years, although the East Indies can extend their plantations almost indefinitely. Southern Siam and all of the coastal plains of Cambodia, Annam, and Tonkin could ship an immense amount of copra, were it not for the tremendous ravages caused by the rhinoceros beetle and for the apparent lack of interest, not to say good economy, in this industry.

Broadly speaking then, the Philippines with a rapidly increasing demand in America and with no tariff there on either copra or coconut oil, has clearly a considerable advantage over any other coconut-growing countries, with the possible exception of Java and the Federated Malay States. While there are already known to be some 45 million coconut trees now growing in the Philippines, there are scarcely fifty plantations that can be called even moderately well managed as to modern methods, careful planting, and economical harvesting. Suitable land for this crop still exists, to the extent of scores of thousands of hectares, in at least fifteen provinces.

SOILS AND LOCATIONS.

Scarcely a decade since, the prevalent belief in connection with soil fertility was based upon the theory that the growth and vigor of a plant depended very largely upon mineral elements in the soil. In other words, the "balance" of these mineral substances was paramount in determining the productiveness of any given plat of earth, and much valuable time and effort was spent, not to say entirely wasted, in the work of attempting to determine just what were the most "nutritive" combinations of the mineral, i. e., *chemical* substances in soil "samples." Analyses were carried out to the third decimal point in soil-testing laboratories throughout the world. When, however, the practical tests of plant growers themselves frequently failed to check up with the dicta of the analyzing chemists, the agricultural experts of the world finally concluded that there were tremendous discrepancies between the analyses and the actual results which according to the old theory should be in evidence in the fields from which samples for the analyses were taken. From this conclusion to the discovery of the true basis of soil fertility was but a short step.

In other words, if fertileness did not depend upon the mineral constituents of the soil, as was evident, it must depend either upon its physical condition, or upon its content of the minute organisms, which were known to exist, especially in the superficial layers of all fertile soils, or both. Hence to-day the old theory of chemical values is put away as a curious relic in the history of agricultural science and now even the adherents to the "physical-condition" theory of fertility are losing ground in face of the wonderful progress of the new soil bacteriology.

There are still, of course, many features of soil influences which are far from being fully understood but the principal points which have been worked out to satisfactory conclusions by agronomists and biologists are as follows:

(1) Microörganisms normally exist in vast numbers in "rich" soils and in moderate numbers in ordinary soils, but are comparatively rare in unfertile soils, and, therefore

(2) The degree of fertility is very nearly in direct proportion to the quantity of bacteria and other associated microörganisms.

(3) These germs are known to not only cause the disintegration of the mineral particles of earth, but also to produce a variety of gaseous and liquid by-products, resulting from their vital functions in the process of "tearing down" the inorganic and organic molecules and from their own decay, thus furnishing direct to the plant soluble forms of nourishment which its roots would otherwise be unable to obtain, even though there were an abundance of moisture and all the requisite mineral elements in the soil itself.

(4) These minute purveyors and assistants to the root-hair branches of the roots of plants are influenced, for better or for worse, as the case may be, by other and sometimes exceedingly injurious organisms in the same soil; it is now definitely known that certain animalcules, like amœbæ, prey upon the beneficial bacteria; and on the other hand, certain species of inconsequential character *per se,* leave toxic excretions in the soil water around them, and these solutions naturally affect the vigor of their better neighbors, the friends of the plants.

(5) Certain excretions of plant roots are now (since 1907) known to be exceedingly inimical to the growth of other species of plants in any given area; for instance, the roots of grasses, bamboos, etc., excrete highly poisonous elements into the soil water in contact with them, thus reducing the vitality of, and, in some cases, actually killing the higher plants in their vicinity.

(6) The amount of air in the soil affects the number and vigor of most soil bacteria; generally speaking, beneficial bac-

teria increase more rapidly and resist their enemies better when the soil is well ventilated, i. e., when it contains a comparatively large percentage of the atmospheric gases.

Putting it briefly, coconut roots are helped or hindered in their growth by soil bacteria, by weeds, and by soil ventilation; translating this into economic agronomy terms, coconuts grow well when beneficial soil bacteria are numerous about their roots, when no poisons from grass roots, etc., can damage their vigor, and when a due amount of atmospheric oxygen can permeate the soil particles about their roots so that the adjacent colonies of the beneficial bacteria are stimulated.

Nowadays the coconut planter does not need to be told that clean cultivation is proper, even if he can not always afford it. He knows also that bad drainage, which means bad ventilation, spells failure as far as his economic yield of nuts is concerned. He knows that a shallow soil which is likely to dry out so that the bacterial functions are suspended or deranged, not only retards the growth of the palms, but is indirectly a very serious matter considered in the light of the above principles. Or, putting it in another way, he knows that the coconut is a living organism, the fundamentally important part of which has to be in the surface soil of his plantation, and that all influences which make for or against the healthfulness of the roots of the crop will sooner or later affect the income from his plantation.

Since the coconut does not have a taproot, as most of the higher plants do, it would naturally seem that deep soil is unnecessary, and in a measure this is true; considered from the purely physical side of the question, however, deep soils are safer as regards permanent moisture, which is, of course, an essential feature for highly productive soils; sandy soils, being naturally well ventilated because of their physical texture, favor the healthy development of this crop plant. The coconut root having no root-hairs, as do those of the higher plants, it follows that the comparatively coarse roots of this tree require a rather high degree of moisture without any danger of prolonged drought.

In the deep alluvial soil of the Zambezi Valley the writer has noted coconut roots running to a depth of 2 meters (6½ feet); ordinarily, of course, the "feeding roots" are confined to the first 80 centimeters below the soil surface, the deeper-going roots being principally water-gatherers. By the way, from the fact that a tree like the coconut has a huge mass of leaves at the top of a tall slender trunk and has absolutely no taproot (which is supposed to be requisite as an "anchor" for such trees as rubber), and yet withstands strong winds better than most trees, even those that do have taproots, we are forced to discard an-

other good old theory; the rubber planter, the orange grower, and in general all arboriculturists should remember that it is the lateral roots of the tree which really anchor it in the soil, and in transplanting trees, especially into soil which is not conveniently handled with a shovel, the sensible plan is to regard the taproot as a practically useless and cumbersome appendage, and to cut it off with shears or pruning knife.

The old belief that the coconut enjoys the proximity to sea water is fast dying out, though it still remains in the mind of many coconut growers. It has even been suggested that the coconut requires the sea breeze to attain its best development. The fact is, all wind movement is more or less detrimental to plant tissues since the strain thrown upon the separate cells of leaves and stems by the bending and twisting action of the wind is injurious to the steady circulation of sap and may easily result in shock to the very delicate, jelly-like, protoplasmic contents of the growing cells. Students of biology and meteorology readily tell us that the circulation of sap in plants does not to any appreciable degree depend upon the stretching and straining action of their tissues but upon certain factors like osmosis and capillary diffusion, while "there is about as much need of the wind's stirring the atmosphere to prevent concentration of oxygen over the surface of the leaf, for instance, as there would be in agitating the ocean to prevent an incrustation of salt on the surface on account of the evaporation therefrom."

Many years ago coconut planters in some countries believed that the use of salt around the roots of coconuts was beneficial, especially at a distance from the seacoast, the idea being that the palm delighted in sodium chloride, which is, with few exceptions, a violent poison to the more highly differentiated plants, although the nipa palm happens to be a striking exception to the rule. The only sensible reason, in the experience of the writer, which has been given for the use of salt about young coconuts is that it might temporarily ward off the attacks of injurious insects.

The real reason for the apparent preference of coconuts for the seashore location is based upon the fact that all heavy clayey soils, which hold moisture well throughout the year and upon which falls a comparatively large amount of rain, naturally foster a far greater number of weeds and grass; thus in hilly countries or on comparatively high ground coconuts frequently give a light yield, but not because of distance from the seashore. In fact, some of the best coconut plantations in the world are located many kilometers from the seacoast where no breath of sea wind could reach them. There is, however, something in

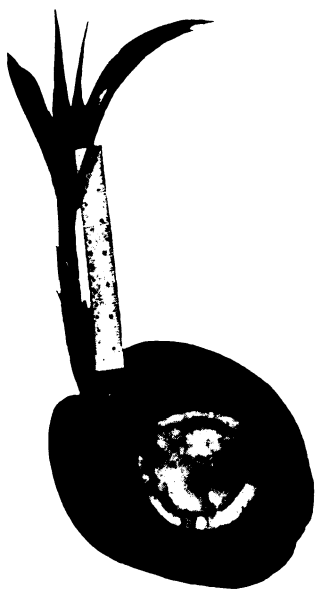
the altitude, or at least in the great diurnal range of temperature which occurs, of course, at high elevations; all plants are more or less sensitive to these severe changes in temperature and the great bulk of vegetable tissues are impatient of even moderately low temperatures. In other words, high altitudes are impossible for the proper development of most tropical plants.

The coconut endures an elevation of 500 to 800 meters (1,500 to 2,500 feet), but above 1,000 meters the temperature conditions are not favorable. Dr. O. F. Cook reports coconuts thriving in central Guatemala up to a height of some 800 meters. The writer has been greatly impressed with the comparative vigor of the coconuts well up on the north side of Mount Banajao in Laguna Province; though the plantations are execrable from the expert agronomist's point of view, being not only choked up with brush and tall grass but the trees themselves standing two or three times too near together, the vegetative condition of the palms is all that could be desired.

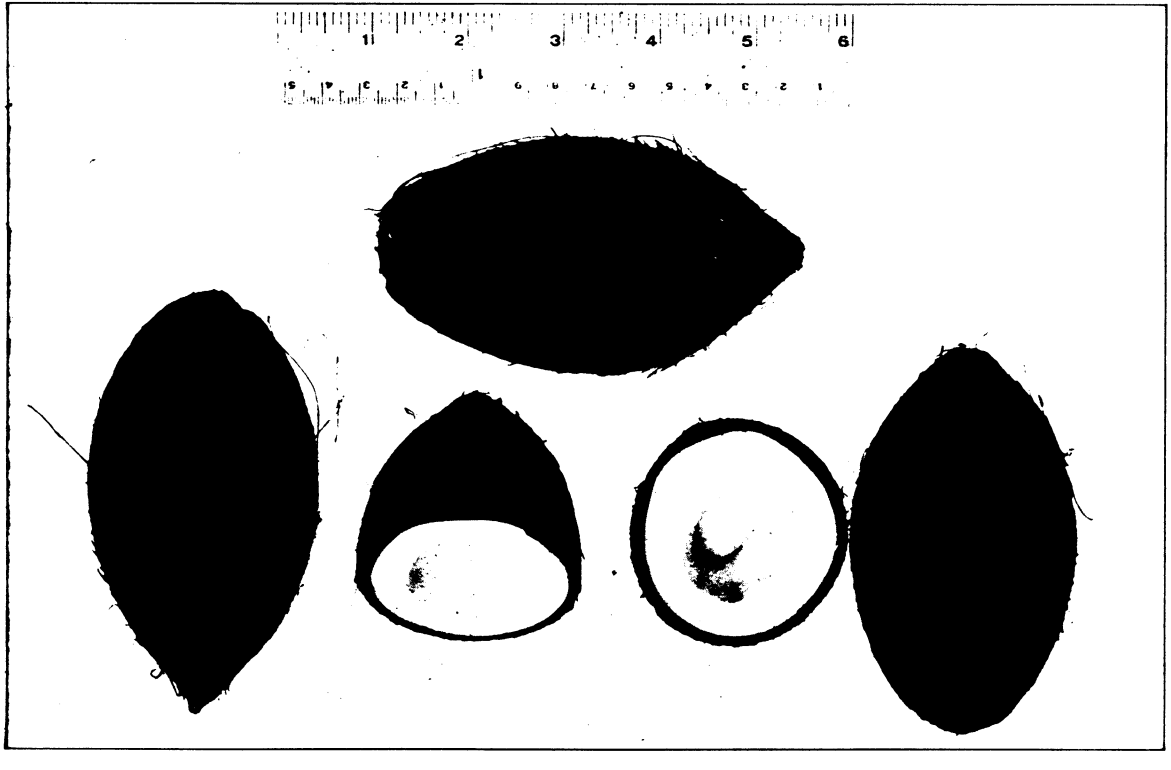
The simplest means of ventilating soil in coconut plantations, though actually necessary, however, only in heavy soils and in young plantations, is the vertical-forking method, first proposed by the writer in 1907 in the West Indies in a lecture before the Agricultural Society of Trinidad and Tobago; this consists in forming vertical openings in the surface layers by means of a strong-tined fork thrust into the earth to a depth of 10 to 20 centimeters (4 to 8 inches), then loosened by moving the handle of the fork back and forth, or sidewise, and, after sufficiently loosening the tines, withdrawn without any prizing action (which might break the roots that come into contact with the tines). From four to eight or more thrusts should be made in every square meter of surface. This operation not only allows the air to enter several different layers of the soil, but the holes themselves collect fine humus and surface material, especially if there is sufficient rainfall to move such substances on the surface; thus the bacteria about the plant roots are furnished a ready supply of nourishment without expense and without disarranging the balance or checking the operations of the microorganism colonies in the soil; plowing would be both too severe and too expensive.

Generally speaking, plowing can not be done with safety near coconuts; harrowing, except superficial cutting and tearing of weeds and grasses by means of a disk or rotary harrow of some light-weight type, is inadvisable, and fertilizers are questionable in ordinary cases, but the vertical-forking method is exceedingly

(*a*) SPROUTING COCONUT, SHOWING "EMBRYO FOOT" GROWING INTO CAVITY AND ROOTS BEGINNING TO FORM ABOUT "EYE".



(*b*) SPROUTING COCONUT. "EMBRYO FOOT" FILLING CAVITY.



DROUGHT NUTS: ONE HALF-SECTION SHOWING "EMBRYO FOOT" JUST BEGINNING TO DEVELOP NEAR THE "EYE".

TYPICAL OLD PLANTATION SHOWING YOUNG TREES SET BETWEEN ROWS OF CLOSELY PLANTED OLD ONES: A STAND OF ABOUT 500 PALMS PER HECTARE. NEAR PAGSANJAN, LAGUNA.

OLD GROVE NEAR MAGDALENA, LAGUNA, SHOWING PRACTICALLY NO FRUITS ON ACCOUNT OF CLOSE PLANTING AND PROLONGED DROUGHT.

TYPICAL OLD-STYLE GROVE: NAUJAN, MINDORO.

Note steps cut in trunks, excessively close planting, and lack of fruits.

COCONUT GROVE SHOWING INTERPLANTING OF BANANAS.

Even with no cultivation and shaded by the palms a few bananas produce fruits. Near Pagsanjan, Laguna.

simple, far cheaper than spading, and much less dangerous to the coconut roots, and is the only practical means of ventilating the earth in heavy soils without injuring the trees.

Unless cut off by "esteros" (tidal runways) from the surface flow of fresh water from high ground, the coconut may flourish on the very strand itself; it should be remembered that there is a slight trend seaward in all soil water, and, if there be sufficient force in this subterranean movement to counterbalance the mingling tendency of the sea water, a coconut may stand on the beach with part of its roots below high tide level. In level low ground entirely surrounded by salt water, however, no coconuts should ever be planted. Stagnant water, even if not brackish, is a menace anywhere in the plantation. Yet many planters have tried to grow coconuts in salt marshes and swamps, and the writer once heard a planter boast that he had succeeded in irrigating a portion of his plantation with sea water.

Shallow soils underlaid with hardpan or even porous coral rock are inimical. The thick, blunt-ended coconut roots are unable to penetrate such strata and hence where an ordinary tree might grow fairly well under these adverse conditions, the coconut can only exist.

SEED MANAGEMENT.

The care of the seed may be divided into three groups of operations: (1) The selection of the seed for the nursery or seedbed; (2) the care of the germinating nut; and (3) the removal of the seed plant. In its broad sense, then, the selection and care of seed for coconut plantations embraces several very important operations and upon the proper meeting of the requirements up to the point of transplanting rests a considerable part of the future welfare of the grove. Since it can easily be seen that any small mistake at the beginning, one, for instance, which stunts or weakens the young palm, will surely retard the growth and reduce the yield of the mature tree, every effort must be made by the planter to prevent any avoidable loss through mismanagement of the seed and the seedbed operations. By ignoring this principle the average planter cheats himself out of large sums.

In the selection of the seed for the nursery three points must be borne in mind: First, the seeds should be taken only from such trees in the plantation as are known to bear *well* and *regularly* and to be of the very best variety; second, the nuts should be completely matured; third, the nuts should be so picked as to avoid the danger of cracking the shell or injuring the embryo,

or "eye." It is not necessarily the tree which happens to have the most fruits at the moment, but the one which always has a large number of bunches in various stages of growth that should be selected for propagation; in this respect there is a greater amount of individuality in coconut trees than is generally believed. The ripe bunch of seed nuts, if from a tree of more than 8 meters, should be lowered to the ground with a cord instead of allowing the nuts to fall. One or two at the tip of the bunch are usually unfit for seed. A roundish nut is preferable to an oblong one. The largest nuts do not always contain the most "meat." In short, then, the planter should be as cautious in selecting his seed as he would be in choosing animals for breeding purposes.

One important feature in seed management should not be lost sight of: The seed nut as it usually comes from the tree is botanically matured but physiologically not quite ripe; therefore, the seed should be "cured" for from two to four weeks before putting into the seedbed, thus insuring complete deposition of the food materials inside the shell. Unless the "meat" is quite sŏlid at the time of planting, some form of internal decay or fermentation may be set up within the shell if external conditions happen to be abnormal. It is natural that the ripened nut should fall from the tree and lie for some time in the shade on top of the ground; when partially covered with fallen leaves so that the husk is kept more or less moist, at least in its lower portion, germination begins. The planter should improve somewhat upon this natural process by completely drying out the husk of the seed nut either on a raised bamboo platform or upon a heap of clean dry sand, and then taking care that the germination once started shall not be interrupted or in any way checked.

The seedbed or nursery should be located in partial shade (for instance, under tall coconut trees at the edge of the plantation) so that the germinating nuts and young plants will be protected from the drying action of the hot sun during the middle of the day; a cheap shed of bamboo posts and cross pieces with coconut leaves laid on top is preferable. The soil should be sandy or at least well drained; richness is not of much importance. In low, wet locations, the nuts may be laid 40 or 50 centimeters apart in rows on the ground, and earth thrown over them; these ridges or rows should be 1.5 meters (say, 4 to 5 feet) apart. In drier places, especially if the seedlings are to remain several months in the nursery, the nuts should be planted in regular rows about 1 meter to 1.25 meters each way. Dangerous overcrowding in the nursery is too common.

The soil should be free from decaying wood and grass roots. The nuts must be laid *on the side* and just covered with earth; a common mistake is to set them on end. While the live bud of the germinating nut grows straight for the strongest light the roots on the other hand grow toward the most moist material and unless they can immediately pierce the husk about the so-called "eye" and thus enter the soil and begin supplying moisture and mineral food materials to the young plant, a setback must needs result; that is, if the nut be planted with the "sprout end" upward, the tender roots will be obliged to force their way slowly down through the tough husk lengthwise, a distance fully six times as great as is the case when the nut is properly planted on the side.

A blanket of rice straw, grass, or coconut leaves placed over the germinating nuts will hasten the sprouting; this covering should be removed, however, as soon as the leaves appear.

The seedbed should be watered frequently during the dry weather so that the young roots may receive no check. From the beginning to the end of the process, the husk of the nut should not be exposed to drying winds; hence the sprouting of nuts in heaps or rows on the ground is seldom advisable. The husk should never be cut in any way.

TRANSPLANTING.

A quite common mistake in the Philippine coconut plantations is the delayed removal of the seed plant from the nursery. It must be remembered that there is a critical stage in the early life of the plant, at which it is dangerous to move it; so long as the young plant is subsisting on the nutriment contained in the seed nut it can safely endure rough handling and even the loss of its roots, but at the period when the supply of food in the nut is exhausted and before the plant has made sufficient roots and a "heart" or stem of its own (with a quantity of reserve sap), the vitality is low and hence a large percentage of the plants may die if transplanted at that time. This period usually occurs between five and eight months after the appearance of the leaf bud and lasts for some three to five months.

Another common fault is the lack of care as to root injury in removing the young plants from the seedbed. The coconut root, unlike that of the banana, does not readily heal when broken or bruised; this means that it is just as harmful to bruise a young root as it would be to remove it entirely. The usual check to the growth of the plant lasting from one to six months or more after setting out in the plantation is accounted for

by the fact that most transplanters break practically all of the young roots from the seed nut at the time of the removal of the nut from the seedbed.

The young plant should be taken from the seedbed, if possible, only during the rainy season. The earth should be well soaked, artificially or naturally, before the plants are removed.

A bolo, or better, a very sharp, broad spade, should be used in taking the plants from the seedbed. A clean sharp cut will have much better chances of healing over than a ragged, bruising cut made by a dull blade. The young plants should be set closely into light bamboo trays, which may be carried to the planting center on carts or sleds; the trays should be provided with handles so that they may be carried short distances by hand; tying together the corner stakes with two or three strands of bejuco (rattan) will prevent the toppling over of the seed plants in these trays.

Still another very important feature is the prevention of injury to the navel, or point of union between the young shoot and the mother nut; a very large amount of damage is done not only in the Philippines but practically wherever coconuts are grown by the planters' failing to observe this point. The slightest strain or crack, even if invisible to the eye, weakens the young shoot, and may give admission to very injurious bacteria which are liable to cause the immediate death of the entire plant; this alone can probably account for 30 per cent of the losses resulting from transplanting into the field, although these losses are frequently ascribed to white ants, drought, or heavy rainfall.

As previously stated, there are really two periods in the life of a young plant at which it may be removed from the nursery to the grove. Other things being equal, the first stage has several advantages over the latter, but the planter frequently is inclined to prepare the nursery at once and to clear his ground for the young palms later. Delays in clearing operations frequently render it necessary to postpone removal of the plants from the seedbed at the first stage in their growth and while there is no great harm done provided good care is exercised in handling such plants, which may be anywhere from ten to twenty months old, the difficulty in transporting these heavier plants is a very serious drawback, not to mention the far greater percentage of loss in handling.

From every 100 selected and cured seed nuts the planter may calculate upon ninety-five vigorous young palms in his grove at the end of six months from the first appearance of the green

shoots in the seedbed; however, if the plants are kept in the nursery until they have exhausted all the nourishment in the mother nuts, the loss in transplanting may amount to 10 or even 25 per cent. The writer recalls the case of an estate in Mozambique where purely through mismanagement of the seedbed and transplanting operations, only about 50 trees per 100 seed nuts were obtained.

When large plants are set out, especially if many of their roots have been broken in removal from the nursery, it is necessary to cut off about one-half or at least one-third of each of the larger leaves; this prevents excessive evaporation and possible wind damage before new roots can be formed.

Holes for the young trees should be dug at least one month before transplanting; shortly before the plant is to be set out, however, the hole may be loosely filled with "surface soil" from around the hole, care being taken not to include therein grass roots, or pieces of wood. The holes should be at least 1 meter in diameter and from 40 to 80 centimeters deep depending on the size of the plant; they should be round, of course; absurd directions are frequently given for making them square.

In this connection it should be noted that in alluvial soils and even in those near the seacoast in the Philippines there are sometimes pockets or limited areas of coarse sand or gravel from 50 to 100 centimeters below the surface. In case such material is encountered in digging the hole, the depth should be increased to at least 1 meter, in order that the new roots when starting from the young plant may have a considerable quantity of good earth to draw upon before encountering the inimical coarse material. By the same token, if a stratum of hardpan or even common clay be encountered near the surface this should be well broken up to a considerable depth and, if practicable, to a greater distance than usual from the center of the hole.

None but an experienced laborer should ever "set" the young palm, and he *should not be hurried.* His one or two helpers carefully take the plant from the tray or shallow basket in which it has been brought from the seedbed and, locating the exact center of the hole, gently settle it into its bed of soft fine earth, taking care to save all the roots possible and to allow no air spaces around the mother nut. After the loose earth has been heaped up around the base of the shoot, it is trodden firmly till the earth at the top of the hole is just a few centimeters below the general ground surface, then a light layer of loose earth is scattered over the top—and the work is done,

ready for the bean planter to put in three or four hills of some sort of legume to keep down weeds and grass.

The following table indicates the approximate number of trees per hectare at the usual distances.

Distance between rows.	Number per hectare.	Number per acre.
15 by 15 feet	475	190
5 by 5 meters	400	160
20 by 20 feet	275	110
6 by 6 meters	275	110
7 by 7 meters	200	80
25 by 25 feet	175	70
8 by 8 meters	155	60
30 by 30 feet	125	50
9 by 9 meters	123	50
10 by 8 meters (block)	125	50
35 by 35 feet	85	35
10 by 10 meters	100	40
40 by 40 feet	67	27

The distance between the trees should be *never less than 8 meters;* on deep, alluvial soil it should be 10 meters. The quincunx, or block-of-five system, is better than "square planting;" each tree is set opposite the inter-spaces of the adjacent (and equidistant) rows on either side of it; this plan actually allows each tree about 25 per cent more room than does the "square-planting" arrangement. For example, by quincunxing the planter can give each tree 80 square meters of feeding ground as against 64, the *rows* all being just 8 meters apart in each system.

The following plan is recommended as the best, especially for large plantations on level land; blocks of 4 trees are set out 8 meters apart and around this block extends a space 10 meters wide; in other words, the rows alternate 8 and 10 meters in each direction. This induces a slight leaning of the tree owing to the tendency to grow toward the open space, and this facilitates climbing; the 10-meter-broad stretches also have some advantages in the secondary-crop line, especially during the first eight or ten years. Unless at least 8 meters distance is allowed between the rows of coconuts the yield is seriously affected; indeed, it is believed that the yield of most plantations in the Philippine Islands is fully 50 per cent below normal, due largely to the excessively close planting. This error of too close planting is on a par with the mistake of planting a dozen grains of maize in a "hill;" if only foliage is desired the idea is not so very bad, but if seed is the object the plants must be given a chance to attain a normal healthy development.

CULTIVATION.

While it is probable that the greatest mistake in the culture of coconuts in the Philippines has been too close planting, almost as great a mistake has been the deplorable lack of cultivation. Even in the best of the old plantations only one or two light weedings or cleanings with the bolo, or cutlass, are given during the year. Scarcity of labor or rather a supposedly prohibitive wage rate is the excuse usually offered for this *laissez faire* system. Plate IV shows the appearance of the typical plantation in Laguna Province in the midst of one of the world's greatest coconut districts.

Furthermore nowhere except in some of the very young plantations where American methods are in evidence as in Mindanao is there any attempt at utilizing cover crops in keeping down weeds and grass in the grove. In some of the plantations it is, of course, impracticable to clean and keep free from grass more than a small circle around each tree. There are few young groves, however, either in sandy or clayey soils which are not immediately benefited by the use of some sort of blanket, or live mulch, crop. Probably the next few years will see a great change for the better in coconut growing throughout the Tropics. The idea of grass-root poisoning is only some five years old. The use of legume crops either as soil renovators, weed killers, moisture retainers, or nitrogen suppliers, is comparatively new in most countries, though it has been so clearly worked out by most experiment stations in the Tropics that there is no longer any excuse for the planter to deny himself the benefits of this very valuable agronomic principle.

The amount of cultivation—harrowing, hoeing, and weed cutting—which will be required in the grove depends upon local conditions to a great extent. All kinds of grass are detrimental to coconut roots and cogon (*Imperata cylindrica*) is one of the worst. The feeding space of the roots, especially of the young plants, therefore, must be kept either clean or planted with some kind of beans or similar leguminous plants; these legumes not only help to prevent the growth of grass and weeds, but also supply nitrogen (through the bacteria in their root nodules) and help to ventilate the soil and to keep its surface cool and moist. The small circle about the base of the young palm is quickly "cleaned" with the bolo, or cutlass; but unless repeated every few weeks the roots of the weeds, especially cogon, persist almost in *statu quo*.

During the dry season in all soils, and during all times in very sandy soils, the young plants should be mulched either with a

live legume cover crop or with some kind of straw, grass, or chopped-up coconut leaves; the purpose of this blanket is to keep the sun from overheating and cracking the soil surface (which would check the root growth), and to prevent excessive evaporation from the otherwise bare (or weedy) ground. It should be borne in mind that even these apparently slight influences upon the vigor of the young roots really amount to serious losses through retarding the time of profitable yield, diminishing the productiveness and shortening the life of the tree.

If no secondary crops are grown between the rows of coconuts, the wheel harrow is a very good implement for keeping down the weeds and grass; the disks may be set so as to cut off the weeds and grass just below the surface of the ground. Shallow plowing between the trees is in some cases advisable, but there is some danger of injuring the roots of the palms; the plow should never pass nearer than 1.5 meters to the base of the tree.

As an indirect method of cultivation during the first few years, it is permissible to plant catch crops like maize, beans, peanuts, pineapples, cassava, or sweet potatoes, between the rows of the young coconuts.

A circular area at least 2 meters in diameter about the base of the young palm should always be kept free from weeds and grass; some form of legume cover, such as cowpeas, beans, or native plants, should be grown in this clean area; if a live mulch is not maintained, rice straw, dry grass, or some other dead mulch as previously explained, must be in evidence, at least during the dry season.

The following leguminous species are recommended as cover crops or live mulches in coconut plantations: Centrosema bean (*C. plumieri*), Lyon bean (*Mucuna lyonii*), velvet bean (*Stizolobium deeringianum*), yam bean (*Pachyrhizus* spp.), sword beans (*Canavalia* spp.), and any similar native species; also cowpeas, peanuts, mani-manian (*Alysicarpus* spp.), cacahuate (*Gliricidia maculata*), cadyos (*Cajanus indicus*), and ipel-ipel (*Lucæna glauca*).

The question as to whether secondary or catch crops should be planted in young coconut plantations can only be settled by the superintendent himself. Much depends, of course, upon the soil; for instance, neither a loose white sand nor a heavy red clay is suitable for growing any great variety of secondary crops. Likewise, much depends upon the location of the plantation; for instance, if no good road or waterway is close to the plantation, heavy crops, such as cassava, sweet potatoes, etc., are of little market value, while legume crops, such as beans, mongos, and cadyos (pigeon pea), are generally to be preferred since they

both furnish human food and nourish the soil. Certain cases, with good local demand and cheap transportation, indicate the planting of pineapples, maize, bananas, millets, and even vegetables and small fruits.

In fact there are really two distinct sorts of secondary crops advisable for cultivating in the young coconut plantation: One type, including the so-called cover, or blanket, crops, is used primarily to keep down weeds, retain moisture, improve the physical condition of the soil, and, if they be of the legume family, to get nitrogen from the air and give it to the soil; the other sort, the secondary, side-line, or, as they are commonly known, *catch* crops, are presumed to be of some use either as forage or as food.

Transportation matters may be largely disregarded so far as true cover crops are concerned. Of these there are at least half a dozen good vigorous running beans which, other things being equal, will cover the ground so deeply with their foliage that weeds and grass can hardly gain a foothold, provided the beans are given a fair start, i. e., if the grass roots, brush, and weeds have been thoroughly removed just before planting.

Cowpeas, while not covering much space individually, are easier to handle and are free from the supposedly objectionable feature of climbing; many planters suppose that beans like the Mucunas, which may run 10 to 15 meters, and which, of course, ascend the first coconut within their reach, are "too much of a good thing," and are likely to waste money in over-assiduously keeping them away from the young palms. There is, theoretically speaking, a chance of a very heavy growth of climbing beans injuring a palm of, say, one or two years by the accumulated weight of several vines hanging on the tender young leaves, especially in windy situations; but if the beans grow vigorously enough to apparently overburden some of the young palms, it is an indication that they are doing excellent work in soil renovation and that their growth, at least below ground, will result in much future good to the crop itself.

The so-called "madre de cacao," or cacahuate, is an excellent shrubby legume to use as a cover crop in exposed situations; this is readily propagated from half-ripened or mature cuttings thrust into the ground during the rainy season; furthermore, this shrub may be pollarded, or topped, as often as desired without injuring the vitality of the plant. If the cuttings are set very thickly, cogon and even nut-grass can be killed out in a plantation within eighteen months. When the coconuts no longer require a ground shade between the rows the cacahuate may be readily removed by means of a bolo, or cutlass, and the

branches, stems, and even roots, are valuable both as firewood and for making charcoal. The only objectionable feature is that it drops its leaves for a few weeks during the dry season. Another leguminous shrub which may be used, especially in heavy soils, is the ipel-ipel; this does not grow readily from cuttings but is never deciduous.

Probably the best all around legume cover crop to be grown in ordinary locations, particularly where no use of the seeds or forage is required, is the cadyos (*Cajanus indicus*), or pigeon pea. This frequently unappreciated but widely known shrub grows rapidly from seed, forms a dense head of leaves and branches which may be fed to cattle, furnishes a good supply of seeds which are edible when nearly mature, and performs all the other beneficial services to the main crop that any legume can be expected to do. It lives about fifteen to twenty months reaching a height of 3 to 4 meters. Pollarding may be done during the rainy season.

A considerable amount of attention has recently been drawn in Ceylon to a new kind of indigo culture, new as to variety and method of handling. It is claimed that when interplanted with coconuts this leguminous catch crop can be made to not only pay for the expense of its own cultivation but for the *upkeep of the main crop itself.* It behooves the up-to-date planter to make experiments not only with indigo but with any other similar crop having a place among the standard dyes, starches, tannins, and medicinal plants.

Among the more important crops to be cultivated as adjuncts to the coconuts are maize, sweet potatoes, beans, peanuts, pineapples, and upland rices; these can be grown in most coconut plantations and, being planted between the coconut rows the first four to six years of the life of the plantation, the planter not only gets a fair return in food for the laborers but in some cases there is even an overage for export. Other foods may be produced, such as bananas, of which there are about a dozen varieties of commercial importance to be obtained readily in the Philippines; cassava, also of several varieties; papaya; millets; grain sorghums, or kafir corns; dasheens, or taros; yautías; and sincamas, or yam beans; all these may also under careful management become important crops in the coconut estate.

In heavy soils, of course, it is not to be expected that sufficient labor will always be available for keeping down weeds and grass in order that these secondary crops will have the best chance, but with a moderate amount of experience in similar matters the average coconut planter should be able to grow at least two, if not four, catch or food crops without materially increasing

the upkeep of the young plantation. The bare cost of labor for handling the catch crops should not be considered too seriously by the superintendent, for he must remember that the soil itself is being greatly benefited by this ventilation and weed-killing work, while the young palms quickly respond to every attention in the way of assisting their roots to a better hold on life.

Open, or clean cultivation, however, can not be recommended, for, though excellent in theory, its practice is nearly always prohibited by the labor wage.

SELECTION OF SITE.

In the choosing of the location for a prospective plantation, the planter must be guided by several matters, among the more important of which are suitability of soil, nearness to transportation routes, freedom from typhoon dangers, availability of labor supply, and freedom from insect pests and fungus diseases.

The questions of soils and the physical aspect of locations have already been discussed.

The question of locality considered as to transportation routes can be passed over with the following remarks:

Generally speaking, the plantation should be near ocean steamer routes, or at least on rivers navigable for good-sized launches. Hauling over earth roads, or even over the very much improved modern highways, which are now being constructed throughout the most of the cultivated districts of the Archipelago, is always expensive; this is largely on account of the comparative scarcity of draft animals in the Philippines at present. The carabao, though very strong, is slow and liable to disease; the native and Indo-Chinese bullocks, or "vacas," while fairly fast, are small and comparatively expensive animals to keep. Only a very few highways are in condition for auto trucks. Long hauling of the unhusked nuts by land is out of the question; in some instances they may, of course, be floated in rafts containing 1,000 to 10,000 nuts (Plate I.) from the plantation to the oil or copra factories; the outside ring and a few cross strands of fibers from the cabo-negro palm (*Arenga saccharifera*) serve to retain the mass intact in calm water, and the rim of husk-tied nuts twisted over the rope hold the center nuts from diving under or falling over the edge. For short distances, however, the nuts may be hauled on cheap bamboo sleds or carts. One great trouble with the transportation of the raw product is the difficulty in traveling during the rainy season over any except metalled roadways. Hence, briefly, the planter in selecting a site for a plantation must bear in mind that the hauling of all raw material and supplies over earth roads is a

precarious proposition, that so far as possible the plantation should be located either close to some good harbor where steamers can call for freight at frequent intervals even through the so-called typhoon season (from June to October), or on a railway line.

The question of typhoon danger is a serious one as regards the Visayas, or central portion of the Archipelago. The coastal region of Samar, the easternmost of this group, has been densely planted with coconuts and the figures for the fiscal year 1912 indicate that some 4 million coconut palms are in evidence there. Even at the southeast end of the island one of the world's largest solid coconut areas existed—in this the very most exposed part of the Philippines, right in the track of the typhoons which usually strike the middle of the Archipelago from the direction of the Marianas or the Carolines. The violence of these "baguios," as they are locally known, is so great that in some cases a considerable percentage of the trees in an exposed plantation may be broken or twisted off about midway of the trunk, in which case practically all of the nuts and many of the leaves are torn from all those which are left standing. A recent typhoon which passed over Leyte, lying west of, and near to, Samar, broke down or stripped many trees in comparatively narrow wind lanes, leaving the adjacent palms practically untouched. The ordinary "baguio" of the central and northern regions of the Archipelago, however, usually extends over a belt 200 to 500 kilometers wide and its violent stage lasts from twelve to thirty-six hours.

Mindanao is seldom struck by the full force of a typhoon. The southern portion of this great island and the Sulu Archipelago, stretching down to Borneo, is coming to be considered an almost ideal location for coconut plantations; this is largely on account of the comparative freedom from typhoons but also partly because of the peculiarly even distribution of the rains in that region. While the greater part of Luzon and most of the Visayas are afflicted with a drought of more or less intensity between December and June, the southern islands have a well distributed rainfall and this is, of course, of great importance, especially to a young coconut plantation.

While there are many protected valleys in the Visayan Islands wherein coconuts can probably be raised with comparatively little danger from strong winds, the matter of transportation in all situations back from the coast or navigable rivers nullifies the advantage that might be gained by using hillslopes or mountain ranges as wind shelters.

Laguna Province has the best, or at least the most protected sites; there are already some 5½ million coconuts in evidence there, Tayabas alone exceeding this number (by 1⅛ millions). Albay, midway of the southern Peninsula of Luzon, stands third in the list, with 4⅛ millions; and Samar is believed to have upwards of 3½ millions.

There are numerous small islands, especially about Palawan, Mindoro, and Busuanga, that offer fair facilities for coconut growing. The principal advantages of these islands, which may be readily turned into individual estates in some cases, are based upon the fact that they may be much more easily ridden of wild pigs and deer; the ordinary insect pests and diseases may also be much better controlled provided due care is maintained in regard to their introduction from outside through young plants or sprouted nuts. Rats may also be controlled on a small, but only with great difficulty on a large island. The disadvantages of the small island are its isolation, difficulty in regard to transportation questions, possible scarcity of labor and fresh water, its probable flatness and therefore exposure to strong winds, and, in many cases, its poorness of soil.

The question of the purchase or lease of land for coconut plantations is a complicated one and this bears strongly upon the matter of the purchase of mature groves in opposition to the purchase of unbroken land for prospective plantations. In very few cases can profitable plantations be purchased at what would commonly be called a fair price. In this connection it must be understood that nearly all of the older plantations in the Philippines are at present in the hands of either Filipino or Spanish property owners, and these proprietors seldom care to give up their holdings except for what would seem an exhorbitant price. In this connection there again comes up the matter of the old and unfortunate custom of treating all these questions on the basis of the *number of* trees instead of the area of the *ground.* Throughout Luzon and the Visayas it is the custom to purchase, lease, and exchange all coconut plantings on the basis of a more or less fixed price per tree. It follows, therefore, that the more trees a planter can crowd upon a given area of ground the more he may expect to receive from this area when disposing of it, and this custom has been largely to blame for the absurdly close planting so painfully evident on most of the old estates. (Some groves run over 500 per hectare, or 200 per acre, four or five times too many; yet many of these trees yield 10 to 30 nuts per year—which means that the system is really not so execrable as it would seem from

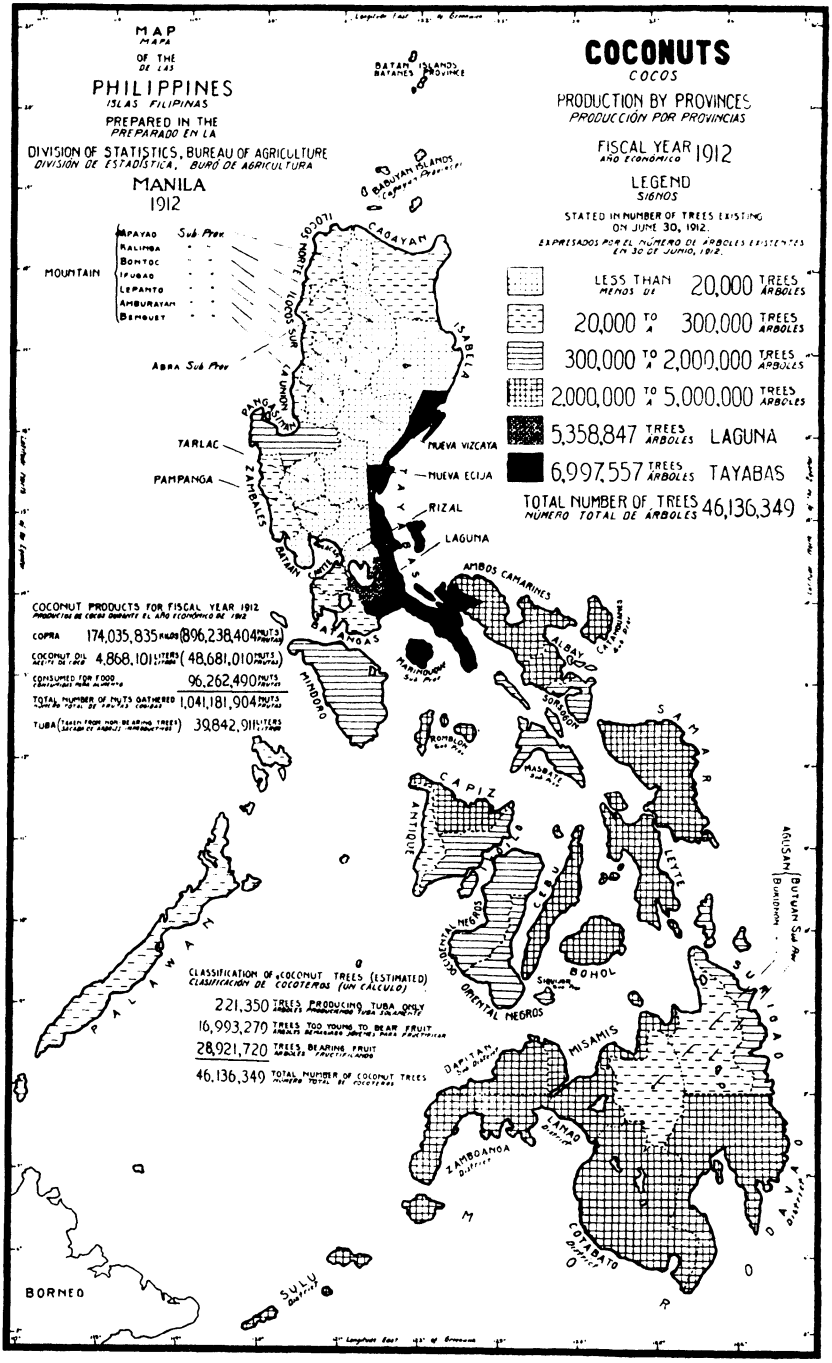

MAP
MAPA
OF THE
DE LAS
PHILIPPINES
ISLAS FILIPINAS
PREPARED IN THE
PREPARADO EN LA
DIVISION OF STATISTICS, BUREAU OF AGRICULTURE
DIVISIÓN DE ESTADÍSTICA, BURÓ DE AGRICULTURA
MANILA
1912
COCONUTS
COCOS
PRODUCTION BY PROVINCES
PRODUCCIÓN POR PROVINCIAS
FISCAL YEAR 1912
AÑO ECONÓMICO
LEGEND
SIGNOS
STATED IN NUMBER OF TREES EXISTING ON JUNE 30, 1912.
EXPRESADOS POR EL NÚMERO DE ÁRBOLES EXISTENTES EN 30 DE JUNIO, 1912.
LESS THAN 20,000 TREES ÁRBOLES
20,000 TO 300,000 TREES ÁRBOLES
300,000 TO 2,000,000 TREES ÁRBOLES
2,000,000 TO 5,000,000 TREES ÁRBOLES
5,358,847 TREES ÁRBOLES LAGUNA
6,997,557 TREES ÁRBOLES TAYABAS
TOTAL NUMBER OF TREES NÚMERO TOTAL DE ÁRBOLES 46,136,349
BATAN ISLANDS
BATANES PROVINCE
BABUYAN ISLANDS
CAGAYAN
ISABELA
ILOCOS NORTE
ILOCOS SUR
LA UNION
MOUNTAIN
Apayao Sub Prov
Kalinga
Bontoc
Ifugao
Lepanto
Amburayan
Benguet
Abra Sub Prov
PANGASINAN
TARLAC
PAMPANGA
ZAMBALES
BATAAN
NUEVA VIZCAYA
NUEVA ECIJA
RIZAL
LAGUNA
BATANGAS
AMBOS CAMARINES
ALBAY
CAMARINES
SORSOGON
MARINDUQUE Sub Prov
MINDORO
ROMBLON Sub Prov
MASBATE Sub Prov
SAMAR
CAPIZ
ANTIQUE
LEYTE
CEBU
NEGROS OCCIDENTAL
NEGROS ORIENTAL
SIQUIJOR
BOHOL
MISAMIS
DAPITAN District
ZAMBOANGA District
LANAO District
COTABATO District
DAVAO District
AGUSAN (BUTUAN Sub Prov)
SURIGAO
PALAWAN
BORNEO
SULU District
COCONUT PRODUCTS FOR FISCAL YEAR 1912
PRODUCTOS DE COCOS DURANTE EL AÑO ECONÓMICO DE 1912
COPRA 174,035,835 KILOS (896,238,404 NUTS)
COCONUT OIL 4,868,101 LITERS (48,681,010 NUTS)
CONSUMED FOR FOOD 96,262,490 NUTS
TOTAL NUMBER OF NUTS GATHERED 1,041,181,904 NUTS
TUBA (TODY FROM NON-BEARING TREES) 39,842,911 LITERS
CLASSIFICATION OF COCONUT TREES (ESTIMATED)
CLASIFICACIÓN DE COCOTEROS (UN CÁLCULO)
221,350 TREES PRODUCING TUBA ONLY
16,993,270 TREES TOO YOUNG TO BEAR FRUIT
28,921,720 TREES, BEARING FRUIT
46,136,349 TOTAL NUMBER OF COCONUT TREES

Fig. 1.

the outside). In fact, in many instances the custom has been carried so far that when a grove fails to produce a profitable yield, it is *planted up with new coconuts* set between the original rows, all the old trees of which are, of course, left standing, producing very few nuts themselves, and, of course, shading and gradually starving to death most of the young plants beneath them (Plate IV). While it is very difficult to break away from this deplorable custom, the prospective purchaser of a mature plantation should, if possible, insist upon an accurate survey and measurement of the ground with, of course, a due examination of the old titles, which are not always as good as perhaps they might be.

Though it is not easy at present to acquire first-class coconut sites in the better districts of Laguna and Tayabas Provinces, there are still a few suitable localities unoccupied, especially in the latter province. If not already planted to coconuts or some other crop these lands can usually be secured for a fair price.

One of the most encouraging features is the regulations promulgated by the Bureau of Lands[1] under which tracts may be obtained by lease or purchase. Under the present regulations a prospective planter may purchase not more than 16 hectares (38½ acres) of land; a copartnership may not purchase a greater quantity than 16 hectares for each partner; a corporation, or like association, may purchase not more than 1,024 hectares (2,530 acres), which is, of course, a comparatively large area for a coconut plantation. The cost of public land is from ₱10 upwards per hectare (approximately $2 per acre).

A qualified person may lease any amount of public land not exceeding 1,024 hectares. Leases of public land run for a period of twenty-five years. The annual rent for the first twenty-five years is not less than 50 centavos per hectare (about $0.10 per acre), and during the second period the rate is not in excess of ₱1.50. (Such land in the Federated Malay States rents for ₱2.16 per acre the first six years, after which the rent is ₱4.32 per annum; this applies to land reached by some means of communication, such as river, railway, or road.)

Thus it is seen that other things considered the prospective planter has a choice of two very reasonable plans whereby he may acquire a tract for coconut planting. The matter of choosing between these depends largely upon local conditions; private planters will probably incline toward the leasing of small select

[1] See Bureau of Lands Circulars dated November 23, 1905; May 1, 1906; November 1, 1911.

areas, if the location is all that could be desired, while, after assuring themselves of the suitability of the tract, corporations will endeavor to purchase outright.

PESTS, DISEASES, AND ENEMIES.

Considering the very severe troubles which coconut planters are having in India, Malaysia, Africa, and the Pacific archipelagos, the Philippine planter may consider himself exceedingly fortunate that thus far he has had very little loss from insect pests or blight of any kind attacking his trees.

To be sure the "uang," or rhinoceros beetle, does cause considerable injury, especially in coconut plantations close to large towns, sugar plantations, or forests containing species of wild palms; there has also been one attack of budrot which, however, was promptly checked, and so far as is known, this disease does not now exist in any province. There are a considerable number of minor insect pests which occasionally appear in sufficient numbers to cause temporary worry on the part of a few growers in the usually very limited districts; such an instance (of leaf-eating caterpillars) has just occurred in a limited area in Laguna. The red weevil also is a rather fearsome pest in some places. None of these pests, however, with the exception of the rhinoceros beetle, need worry the Philippine coconut planter, and with a proper understanding of the life history of this beetle, there will soon be very little loss on that score. The methods of control of the "uang" consist in a thorough removal of every coconut stump and section of dead trunk; a careful inspection of the surrounding jungle, if any, for dead stumps of buri, cabo negro, or other large palms, in which the larvæ of the beetle can breed; a daily tree-to-tree inspection of all coconuts so long as any danger even in the *vicinity* of the plantation is known to exist. The adult beetles attack only the tender tissues in the crown of the palm; and fortunately the female does not oviposit in the burrows which the insects of both sexes make in the leaf bases. The larvæ of the beetle breed in decaying vegetable matter, such as banana trash, coconut or other palm stumps, rotten logs, etc. The damage done by the mature insects when present in large numbers, as for instance in the vicinity of Manila, is so great that the vitality of the attacked trees is very greatly reduced and they may even be killed if the number and depth of the burrows is unusually great. The coconut being an endogen, growing at the top and inside, can not produce new tissue to heal up or cover a burrow which once made must always remain a possible source of in-

TUBA TREES, SHOWING AERIAL BAMBOO WALK FOR GATHERING TUBA, NEAR MAYJAYJAY, LAGUNA.

(Photo by C. M. Conner.)

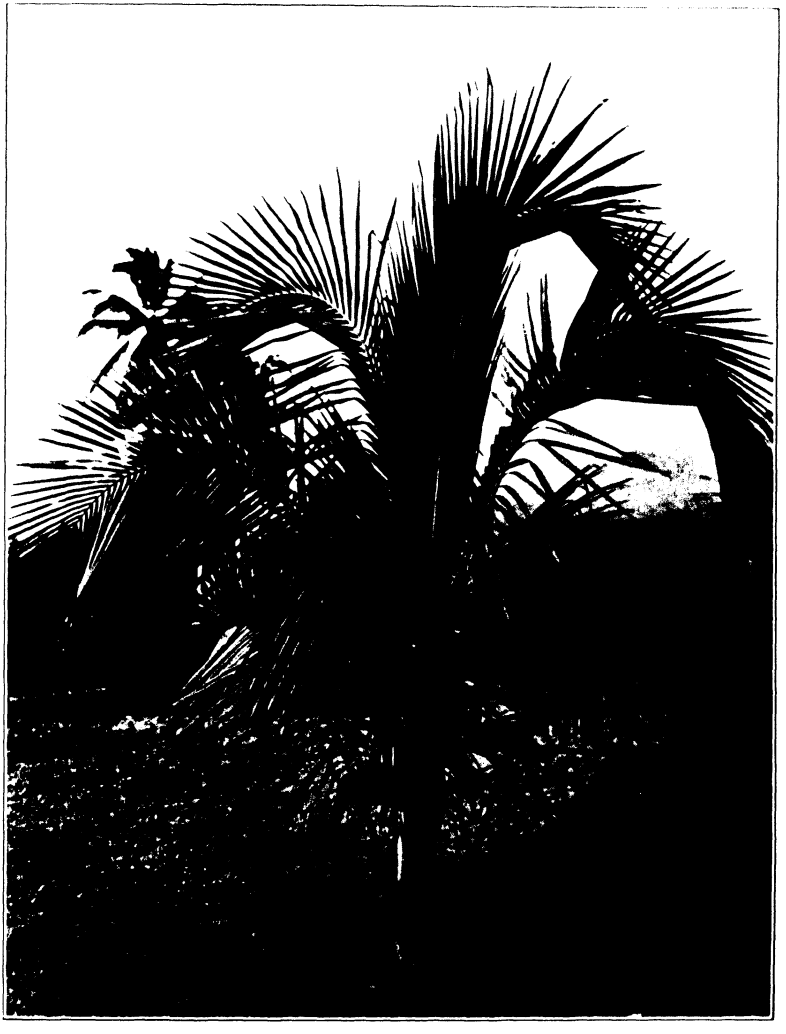
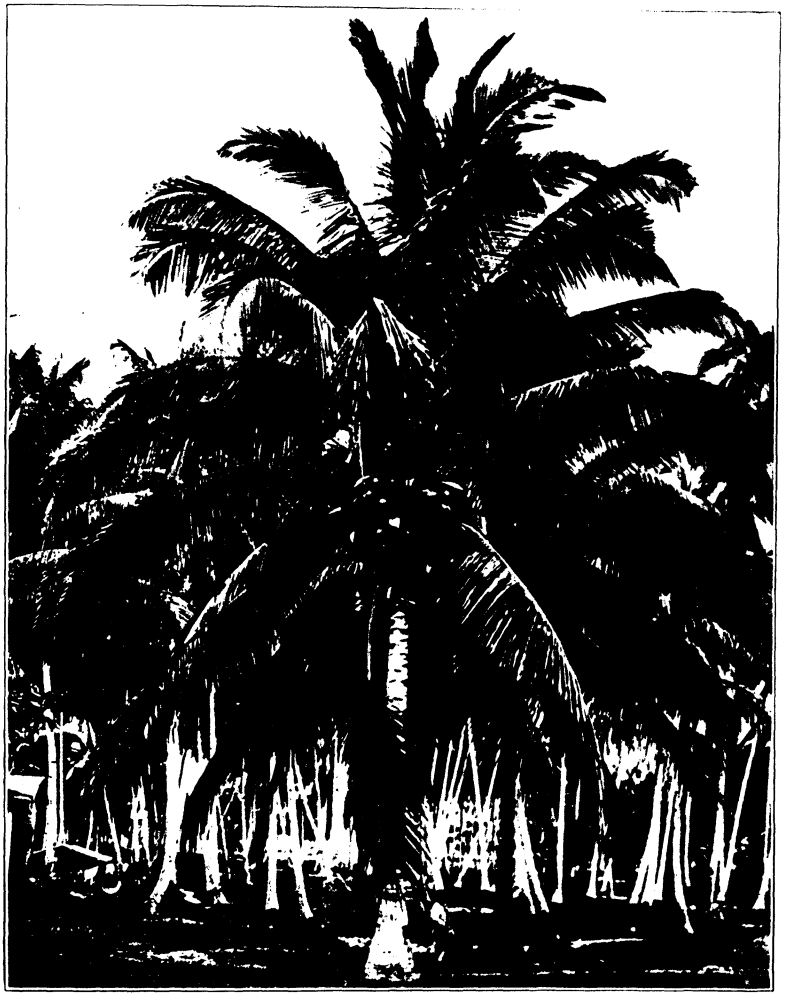


Photo by Gibbs, Zamboanga.

ONE-YEAR-OLD COCONUT GROWN UNDER CULTIVATION, PATALON COCONUT ESTATE, ZAMBOANGA, MINDANAO.



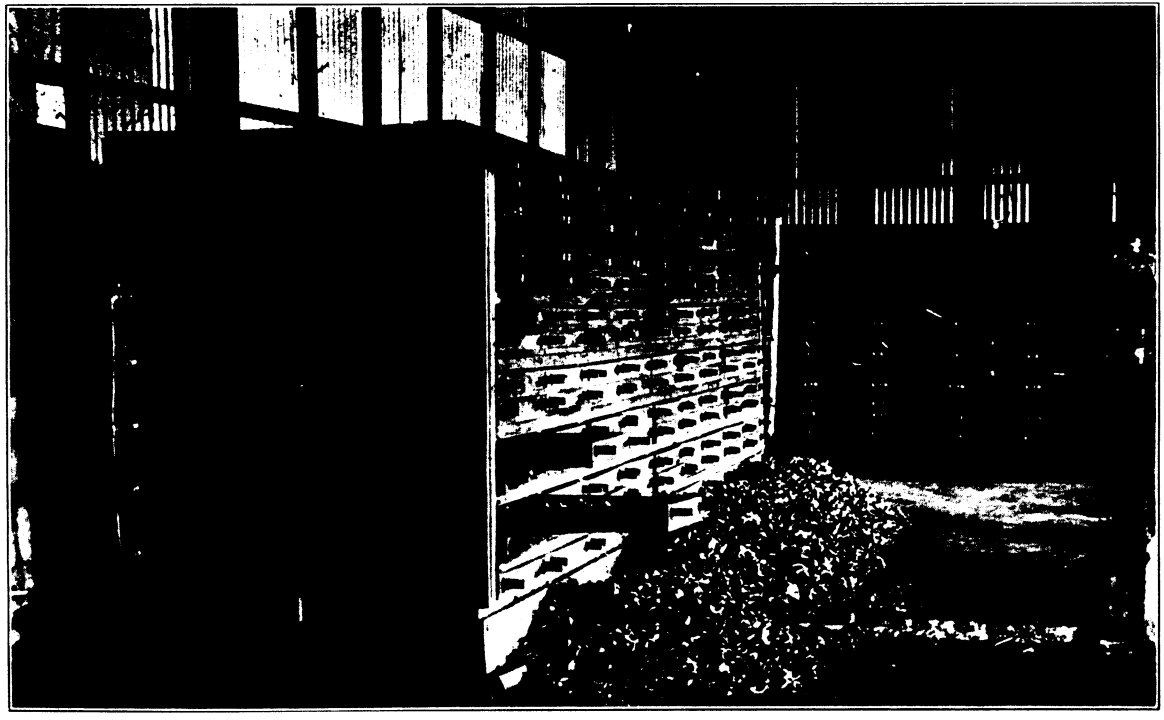
EIGHT-YEAR-OLD COCONUT.

Grown with very little cultivation; 158 nuts when photographed, 50 nuts having been harvested ten days previously, San Ramon penal farm, Zamboanga, Mindanao.

HUSKING COCONUTS WITH COMMON FILIPINO PLOWPOINT SET IN TRIPOD.

"TAPAHAN" OR COMMON TYPE OF KILN, FOR DRYING COPRA.

Note smoke rising through copra over the sunken furnace; a carabao coconut sled at right.



MODERN COPRA DRIER, THE BONITO STEAM-PIPE-OVEN TYPE.

Oven contains 117 trays, capacity 50 piculs per day. Magdalena, Laguna.

fection by fungi or bacteria. Even when the burrows are shallow, i. e., not reaching the soft tissues of the interior of the "cabbage," or bud, at the top of the trunk, the circulation of sap in the attacked leaf base is more or less obstructed. The ragged or deformed appearance of leaves is a sinister reminder to the planter that the "uang" has already paid him a visit.

At least one laborer on every plantation should be trained to look for evidences of the "uang," and this laborer should be paid not by the day but by the number of beetles collected; other things being equal, a very high price should be placed on all beetles, adults or grubs, captured in the plantation and the planter must remember that the destruction of one female may virtually save some dozens of trees from grave injury in the second year following.

By carefully examining the ground under each coconut tree (except in windy weather) the laborer trained in the destruction of this pest can usually note a few particles of tissue torn out by the beetle in making the burrow; finding fresh traces on the ground beneath a tree the "uang man" may be fairly certain of capturing a beetle by climbing that tree. It is of interest to note that in India the natives are said to detect the presence of a burrowing beetle in the tree by holding the ear to the trunk for a few moments, the noise made by the beetle in snapping in two large fibers being telephoned down the trunk to the listener.

In controlling the red weevil (*Rhyncophorus ferrugineous*), the following facts should be borne in mind: This species normally passes its entire existence in the trunk of the coconut, or some other similar palm; the female lays her eggs in a crack or wound made very likely by the bolo, or cutlass, and the young grubs immediately bore their way into the soft starchy tissues in the interior of the trunk; usually more than one grub is found in a cavity and as many as a hundred or more may sometimes be taken from old cavities; the larva makes a sort of cocoon out of shreds of the fibers and in old infested areas it is possible to find not only larvæ but also pupæ in these cocoons, besides the mature insects in and around them. Except in the early stages of the attack where the cavity has extended only a few centimeters (say, 5 inches) inward, it is advisable to cut down the tree at once because the mere cavity itself would always remain a menace to the health of the tree even when opened on the lower side to prevent water settling therein.

There are several other weevils, and beetles of the Lamellicorn family, which attack the coconut in rare cases, but the preceding directions apply either to the trunk feeders or bud borers.

Several species of scale insects attack the leaves, especially of old or weakened specimens. In the case of very young plantations it may be advisable in some cases to spray leaves attacked by scales but, generally speaking, a little extra attention given to the tree in the way of removing the older and more badly infested leaves (and burning them, of course) and by giving a good stirring to the soil around the tree, removing all weeds and grass, and applying a moderate amount of stimulating fertilizer or ashes, will usually invigorate the tree so that it "grows away from" the pest.

A leaf-miner, a bagworm, and several leaf-eating caterpillars are in very rare cases known to attack Philippine coconuts but the injury caused thereby is a negligible matter. Other countries suffer more, it seems, in this respect.

Budrot is a very serious disease, supposed to be due to a bacillus, which in some unknown way enters the delicate tissues in the center of the crown. This disease is fairly common in India and the West Indies (especially in Cuba where it has killed millions of trees), but so far as authentic records show in this office only one serious outbreak has occurred in the Philippines. The symptoms of the disease are a sudden yellowing and wilting of the central or youngest leaves in the crown; the rapid progress of the infection may cause the death of the entire crown including the dropping of the fruits within a few weeks from the appearance of the first symptoms. So far as is known, there is no cure for this disease. The only thing for the proprietor to do, then, is to prevent its spread by *immediately felling every tree showing the least symptom of the disease.* The infected portion, i. e., all the leaves and the upper part of the trunk, should be thrown into the nearest river or into the ocean, or should be deeply buried, or better still, perhaps, should be sterilized by burning over the diseased parts a large heap of dried coconut leaves, brush, or other material which would give considerable heat in the burning.

The "stem-bleeding" disease, so destructive in Ceylon and Malaysia, does not seem to have entered the Philippines thus far.

In this connection it is well to state that in all matters pertaining to pests or diseases of the coconut, the proprietor of the plantation must look well to the possibility of infection from his neighbors' groves, and if it is found that the owners of surrounding groves will not, of their own accord, take proper measures for safe-guarding the proprietor against reinfection from any coconut pest spreading from their plantations to his, he should take the necessary steps to oblige his neighbors to comply

with the local regulations affecting this matter. (Several provinces now have excellent laws dealing with these matters.)

Among the other enemies of the coconut in the Philippines the following are the principal species in order of their importance:

Wild pigs.—In several districts of the Philippines these animals are a great nuisance to all unfenced plantations. They dearly love the "meat" of the nut and the tender shoots, even the base of one-year-old palms being subject to attack. Since these animals are usually too wary to be successfully trapped or poisoned, and since hunting them is a tedious task on account of their nocturnal habits and great cunning, some sort of fencing is almost necessary in badly infested regions like Mindanao, Palawan, and Tayabas. Either the individual fence made by nailing slabs or bamboo to three posts set at equal distances about the young plant, or a boundary fence, constructed preferably of woven wire with barbed wire at both top and bottom, is recommended. In a few places ditches around young groves have proved effectual; the pig will not jump, and once slipping into the trench, runs along it into a pit or trap.

Deer.—In many localities deer are rather serious enemies to young coconuts, the young leaves furnishing very sweet forage for these animals. Though wary of traps, they soon get accustomed to wire fences and unless the top of the fence is some 1.6 meters (5 feet) high they are liable to jump over it. As with the wild pig, a few dogs and a shotgun or two are excellent preventive measures in dealing with these animals.

Monkeys rarely injure coconuts, but when pressed by hunger will sometimes enter a grove on the borders of the forest and may succeed in breaking off a considerable number of immature nuts. An occasional shot fired at them is usually sufficient to stop the depredations.

Rats are accused of doing considerable damage in some districts of the Philippines, though the pest never is of such great importance as in some other island groups, such as the Marianas, Maldives, Seychelles, etc. The rat is rather easily trapped or poisoned, and even if these means fail, a wide strip of tin (from kerosene cans) may be tacked around the coconut trunk, a method which absolutely prevents the rat from getting at the nuts unless some other tree or leaf rests in such a position that a round-about way is offered.

Fruit bats are said to tear off a few young fruits occasionally but the damage from these animals is almost a negligible quantity.

Crows occasionally injure young nuts by attempting to peck holes through the husk in search of the water and jelly inside. These birds may sometimes be poisoned by the use of arsenical baits, such as a mixture of white arsenic and boiled rice. They are said to search for and eagerly devour the "uang" beetles—a real blessing in disguise, it appears.

Crabs.—In a few plantations on the sea beach the land crab (*Birgos latro*) does some damage. A light barrier made by tying a bunch of stiff weeds or brush around the trunk prevents its ascent and arsenical bait (using coconut "meat" as a base) would probably be readily taken.

Termites, while constituting a very grave evil in some countries, are seldom injurious to any great extent in the Philippines. In very new or even in abandoned plantations where there is plenty of decaying wood and coconut leaf bases they may accumulate in such numbers that they attack the living tissues of the palms. In many localities their galleries may be noted running up the coconut trunks to the dead leaf bases at the top. The wise planter will destroy all termite "nests" and colonies on general principles, especially in his new plantations.

Last, but not always least, may be mentioned the migratory locusts. In some provinces, especially in the Visayas, these insects, when migrating, occasionally alight for a short time in coconut plantations and in some cases strip the leaflets to the midrib. This stripping of the leaves, of course, causes a tremendous setback to the tree and the probable loss of all the nuts in all stages of development adhering to the tree at that time. In this connection it should be remembered that the stripping of the leaves practically sets back the coconut *two years,* since it takes about one year for the new leaves to come out and another year for the nuts to form and ripen—locust attacks in this respect being rather worse than typhoon or drought damages. There is, of course, no means of handling this pest in the flying stage and the planter's only means of avoiding it is to see that all "hoppers" are destroyed within at least 100 kilometers of his plantation. Good rules and regulations legally adopted, and effective locust boards with a fair amount of working capital behind them, now exist in almost every province.

GROSS CULTURE.

While the coconut is unquestionably one of the most vigorous and hardy palms in the world and one which most readily adapts itself to various soils and agronomic conditions, there are cer-

tain matters which the coconut grower should always bear in mind regarding the peculiar requirements of this crop.

For instance, he should remember that a low area in his plantation must be drained. He should understand that a gravel pocket or layer of coarse sand must be avoided, or at least the young plants must be assisted in getting a good root-hold by setting them very deeply therein and filling in around them with a generous amount of good surface soil. As explained in the chapter on soils and locations he must remember that grass and weeds, while not necessarily robbing the coconut of any considerable amount of plant food, do exert a very pronounced effect upon the roots of both young and old coconuts. In the matter of pests, diseases, etc., he must remember, too, that a stitch in time often saves more than nine and constant watchfulness on the part of the superintendent is a necessary means to the desired end, which is *no loss nor leakage for which the management may be blamed.*

The question of plowing, cultivating, harrowing, vertical forking, etc., is one which can not be laid down in black and white with any great degree of accuracy. The "average plantation" exists only in theory. No two plantations are very closely alike, for even if the soil appears to be the same in both, the exposure, the subterranean water table and its current, or some distinguishing matter connected with the upkeep is sure to become evident sooner or later. It is not only unwise, therefore, but in some cases quite dangerous to lay down strict rules for the gross-culture methods of coconut plantations. Estimates as to cost of breaking in, planting, upkeep, harvesting, etc., can be generalized, to be sure, but all special items should be reserved by the advisor until he is actually familiar with the case in hand from personal observation.

Generally speaking, the prospective planter may reckon in the vicinity of ₱400 per hectare ($85 per acre) for the total expenses in bringing coconuts into full bearing in ordinary soils. Under native methods commonly practised here the expense is probably not half this amount, while the gross expense for up-to-date plantations with proper distances between the trees is possibly somewhat more, although the income from secondary crops may considerably affect the net cost. Reckoning 125 trees per hectare (or 50 per acre), the cost per tree up to, say, the eighth year should be approximately ₱3.25 ($1.625). With copra at ₱12 per picul and 250 nuts to make 1 picul of copra, the net value per nut stands somewhere near ₱0.04 each or,

of course, a little less on the tree. Now, if the tree produces 25 nuts in its seventh year, it follows that nearly one-third of the cost of the tree is made up by the first crop. The crop, however, should increase gradually up to at least 100 nuts per year. After the tenth year the income per tree should be not less than ₱3 and probably seldom more than ₱5. Above interest on capital, upkeep, labor, salaries, buildings, and all proper debits which could reasonably be charged against the crop there should be then at least 20, if not 40 per cent, income on a well-managed estate after the tenth or twelfth year; some estimates run much higher. On the other hand, there are millions of uncultivated trees that do not yield even a peso's worth of nuts.

The following tables from "Coconut Growing in the Philippine Islands" by the Honorable Dean C. Worcester, Secretary of the Interior, will throw some light upon this subject which is, of course, a prominent one in the mind of the prospective planter:

ESTIMATED COST OF ESTABLISHING A 2,500-ACRE COCONUT PLANTATION ON RENTED PUBLIC LAND.

The following is a statement of the approximate cost of establishing a 2,500-acre coconut plantation and of the revenues which should be derived therefrom at practically the existing market price of copra. It should be remembered, however, that properly dried copra will unquestionably bring a price materially in advance of that commanded by the smoked and imperfectly dried article which at present makes up the bulk of the Philippine product.

This estimate is based on clearing half of the land the first year and half the second year. Two hundred acres of land are reserved for buildings and other purposes. A more liberal allowance is made for the cost of clearing the land and preparing it for planting than is called for by the estimates hereinbefore quoted and as the returns from catch crops will manifestly depend directly on the character of the soil selected and on the efficiency of the administration of the estate, no allowance is made for them.

Practical experience has shown that under capable administration, with favorable soil and market conditions, they may be made to pay the cost of clearing and planting the land and that of keeping it clean during the first two or three years after it is cleared. I am of the opinion that if this is done it is all that can be expected and I doubt somewhat whether it would be feasible to achieve this result on a coral island. Nevertheless, if I myself were selecting a site for a coconut plantation, I should select one on a coral island which was pretty well isolated in order to avoid possible danger of insects and other pests which might result from the fact that neighboring plantations, if any existed, were badly cared for.

First year.

	On ordinary forest land.	On a coral island.
Survey	$250.00	$75.00
Rental	256.00	256.00
Clearing and plowing 1,250 acres, at $20 per acre	25,000.00	
Clearing 1,250 acres, at $10 per acre (plowing not necessary)		12,500.00
Cost of seed	1,656.25	1,656.25
Planting 33,000 nuts, at $0.02½ each	825.00	825.00
Fencing	1,000.00	
Assistant manager's salary	1,800.00	1,800.00
Assistant manager's house	1,000.00	1,000.00
Laborer's quarters	2,000.00	2,000.00
Storehouse for rice, tools, trade goods, etc	500.00	500.00
Well, tank, pumping engine and pipe for water supply	600.00	600.00
1 mile of track (rail, 12 pounds to yard)	765.00	765.00
5 cars, at $30 each	150.00	150.00
Tools	500.00	500.00
15 draft cattle, at $40 per head	600.00	600.00
1 American or Australian horse	150.00	150.00
2 native ponies, at $50 each	100.00	100.00
One 30-foot launch, with 10-horsepower petroleum engine	1,500.00	1,500.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Total	39,302.25	25,627.25

NOTE.—A launch is estimated for because unless the plantation is located directly on some interisland harbor one will be necessary in keeping up communication between the plantation and the nearest port. A liberal estimate has been made for quarters for men, which would allow of putting up a substantial shed, with galvanized-iron roof. It would give the men good quarters and could later, at small additional expense, be converted into a drying shed, while the iron roof would be useful for catching rain water, especially on coral islands. A good well, with a pump, tank and pipe, is essential in order to provide adequate bathing facilities for the assistant manager and men, and water for animals, sprouting nuts, etc.

It would probably be necessary to run a small store in connection with a plantation at which articles of common necessity should be sold at Manila prices, plus 20 per cent, plus cost of transportation, but labor should be paid for in cash and the men left free to trade at the store or not, as they please.

From the total should be deducted the receipts from catch crops, if any, and from the sale of timber and firewood, which on forest land might somewhere nearly cover the cost of clearing and planting. The sandy soil of coral islands will grow pineapples, peanuts, cassava, corn, or yams, but as weeds do not spring up readily on this soil and as comparatively little work is required to keep it clean, it might be more desirable not to plant catch crops but to leave all plant food in the soil for the coconut trees.

It will be noted that I have provided for an assistant manager only. It would be necessary to have one competent man constantly on the ground. There would be necessity for work in other places in connection with the purchase and shipment of supplies, seed nuts, etc., and the securing of laborers, which should be performed by a manager, and

the best way to provide for this unless the owner himself cared to do it would be to have one thoroughly competent man who would serve as general manager for several plantations and who would not only perform the work above referred to but would visit and inspect the plantations at frequent intervals. If the assistant manager proves capable, his salary should be raised $200 per year until it reaches at least $3,000.

Second year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Clearing and plowing 1,250 acres, at $20 per acre	25,000.00	
Clearing 1,250 acres at, $10 per acre (plowing not necessary)		12,500.00
Cleaning 1,250 acres of land already planted, at $10 per acre	12,500.00	
Cleaning 1,250 acres of land already planted, at $5 per acre		6,250.00
Planting 33,000 nuts, at $0.02½ each	825.00	825.00
Fencing	1,000.00	
40 laborers' houses, at $25 each	1,000.00	1,000.00
Assistant manager's salary	2,000.00	2,000.00
Tools	400.00	400.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Depreciation on buildings, track and water system (10 per cent)	451.50	451.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	44,582.50	24,832.50

NOTE.—From the totals above given should be deducted the receipts from the sale of catch crops and from the sale of timber and firewood, if any.

Third year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres of land, at $5 per acre	12,500.00	
Cleaning 2,500 acres of land, at $2.50 per acre		6,250.00
Assistant manager's salary	2,200.00	2,200.00
Tools	250.00	250.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Depreciation on buildings, track and water system (10 per cent	451.50	451.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	16,807.50	10,557.50

NOTE.—From the total should be deducted the value of catch crops, which on forest land should be sufficient to pay the cost of keeping the land clean.

Fourth year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres, at $5 per acre	12,500.00	
Cleaning 2,500 acres, at $2.50 per acre		6,250.00
Assistant manager's salary	2,400.00	2,400.00
Tools	200.00	200.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste for launch	200.00	200.00
Depreciation on buildings, track and water system (10 per cent)	451.50	451.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	16,957.50	10,707.50

NOTE.—From this year on there will be no catch crops of importance.

Fifth year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres, at $5 per acre	12,500.00	
Cleaning 2,500 acres, at $2.50 per acre		6,250.00
Assistant manager's salary	2,600.00	2,600.00
Tools	200.00	200.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
4 miles of track	3,100.00	3,100.00
One-half mile of portable track	1,380.00	1,380.00
10 cars, at $30 each	300.00	300.00
Depreciation on buildings, 1 mile of track and water system (10 per cent)	451.50	451.50
Depreciation launch (20 per cent)	300.00	300.00
Total	21,937.50	15,687.50

NOTE.—On favorable land some nuts will be harvested during the fifth year.

Sixth year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres, at $5 per acre	12,500.00	
Cleaning 2,500 acres, at $2.50 per acre		6,250.00
Assistant manager's salary	2,800.00	2,800.00
Tools	200.00	200.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Depreciation on buildings, track, and water system (10 per cent)	929.50	929.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	17,835.50	11,585.50

NOTE.—The sixth year a half crop of 30 nuts per tree may be estimated. While all the land in the plantation will need to be cleared in the first instance and kept clean thereafter, it will be safe to allow 200 acres for waste land and for that used for buildings, etc., so the crop of nuts for the sixth year from 1,150 acres may be estimated at 1,380,000, which should give 6,900 piculs of copra, worth $34,500, less cost of harvesting nuts and making copra.

Seventh year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres, at $5 per acre	12,500.00	
Cleaning 2,500 acres, at $2.50 per acre		6,250.00
Assistant manager's salary	3,000.00	3,000.00
Tools	200.00	200.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Depreciation on buildings, track and water system (10 per cent)	929.50	929.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	18,035.50	11,785.50

NOTE.—This year a full crop of 2,750,00 nuts may be estimated for 1,150 acres and a half crop of 1,380,000 nuts from the remaining 1,150 acres under cultivation, or 4,130,000 nuts in all, from which 20,700 piculs of copra shou.d be obtained, worth $103,500.

Eighth year.

	On ordinary forest land.	On a coral island.
Rental	$256.00	$256.00
Cleaning 2,500 acres, at $5 per acre	12,500.00	
Cleaning 2,500 acres, at $2.50 per acre		6,250.00
Assistant manager's salary	3,000.00	3,000.00
Tools	200.00	200.00
5 draft cattle, at $40 per head	200.00	200.00
Launch engineer, at $37.50 per month	450.00	450.00
Kerosene, engine oil, cotton waste, for launch	200.00	200.00
Depreciation on buildings, track and water system (10 per cent)	929.50	929.50
Depreciation on launch (20 per cent)	300.00	300.00
Total	18,035.50	11,785.50

NOTE.—During this year and thereafter a full crop of nuts should be harvested from the entire 2,300 acres, amounting to 5,520,000 nuts, equivalent to 27,600 piculs of copra, worth $138,000.

It is believed the above estimates will come very close to the actual expenditures for the average Philippine plantation. At the same time, however, it must be remembered that the exigencies of season, of labor supply, of transportation difficulties, and various other matters must needs enter into all such estimates and may easily have a very considerable bearing upon the income of the proprietor as well as the actual expense of upkeep.

It is of interest to compare the foregoing tables with those drawn up by Mr. J. Shaw Hellier, a planter who has had much experience in Burma and the Malay States, and who intends to immediately put his carefully prepared estimates into practice in one of the southern islands.

ESTIMATED COST OF ESTABLISHING A 2,500 ACRE COCONUT PLANTATION ON AN ISLAND IN THE PHILIPPINES.

Expenditure first year.

Preliminary expenses	$5,000	Store	$500
Survey	100	Water supply	600
Rental	256	Tools	500
Clearing 1,000 acres, at $10 an acre	10,000	Horses	250
Seed nuts	1,500	Cattle	600
Lining, holing, planting	1,500	Recruiting	500
Upkeep	5,000	Launch	1,500
Nurseries	500	Upkeep of launch	700
Salaries	6,000	Landing stage	500
Manager's bungalow	1,000	Stationery, office	500
Assistant's bungalow	500	Medicines	500
Furniture for two bungalows	600	Contingencies	1,000
Coolie lines	2,000	Total	41,606

Expenditure second year.

Rental	$256	Cattle	$200
Cleaning 1,000 acres	10,000	Upkeep buildings	200
Upkeep of 2,000 acres	10,000	Upkeep launch	700
Seed nuts	1,500	Stationery	100
Lining, holing, planting, 1,000 acres	1,500	Medicines	200
Salaries	7,000	Water supply	500
Coolie lines	500	Doctor	1,000
Recruiting	250	Contingencies	1,000
Nurseries	500	Total	35,906
Tools	500		

Expenditure third year.

Rental	$256	Cattle	$200
Cleaning 500 acres	5,000	Upkeep building	400
Upkeep 2,500 acres, at $5 an acre	12,500	Upkeep launch	800
Seed nuts	750	Nurseries	250
Lining, holing, and planting	750	Stationery	200
Salaries	8,000	Doctor	1,000
Coolie lines	250	Medicines	300
Recruiting	125	Contingencies	1,000
Tools	500	Total	32,281

Expenditure fourth year.

Rental	$256	Upkeep launch	$800
Upkeep 2,500 acres, at $4 an acre	10,000	Stationary	200
Salaries	9,000	Doctor	1,000
Recruiting	125	Medicines	300
Tools	300	Contingencies	1,000
Cattle	200	Total	28,581
Upkeep buildings	400		

Expenditure fifth year.

Rental	$256	Upkeep launch	$800
Upkeep 2,500 acres, at $3 an acre	7,500	Stationery	200
Gathering, curing crop	3,000	Doctor	1,000
Salaries	10,000	Medicines	350
Recruiting	125	Curing-house with machinery	10,000
Tools	300	Contingencies	1,000
Cattle	200	Total	35,331
Upkeep buildings	400		

Expenditure first year	$41,606
Expenditure second year	35,906
Expenditure third year	32,281
Expenditure fourth year	23,581
Expenditure fifth year	35,331
Total	168,705

$168,705 = $67.50 per acre.
Hereafter expenditures may be put at $25,000 per annum.

Revenue sixth year.

1,000 acres, at 20 nuts per palm	800,000
1,000 acres, at 10 nuts per palm	400,000
Total	1,200,000

1,200,000 nuts = 5,454 piculs copra, at $5 per picul, $27,270.
Net income, $2,270.

Revenue seventh year.

1,000 acres, at 35 nuts per palm	1,400,000
1,000 acres, at 20 nuts per palm	800,000
500 acres, at 10 nuts per palm	200,000
Total	2,400,000

2,400,000 nuts = 10,909 piculs copra, at $5 per picul, $54,545.
Net income, $29,545.
Interest, 45 per cent.

Revenue eighth year.

1,000 acres, at 50 nuts per palm	2,000,000
1,000 acres, at 35 nuts per palm	1,400,000
500 acres, at 20 nuts per palm	400,000
Total	3,800,000

3,800,000 nuts = 17,272 piculs copra, at $5 per picul, $86,360.
Net income, $61,360.
Interest, 57 per cent.

Revenue ninth year.

1,000 acres, at 60 nuts per palm	2,400,000
1,000 acres, at 50 nuts per palm	2,000,000
500 acres, at 35 nuts per palm	700,000
Total	5,100,000

5,100,000 nuts = 23,181 piculs of copra, at $5 per picul, $115,905.
Net income, $90,905.
Interest, 64 per cent.

Revenue tenth year.

2,000 acres, at 60 nuts per palm	4,800,000
500 acres, at 50 nuts per palm	1,000,000
Total	5,800,000

5,800,000 nuts = 26,363 piculs of copra, at $5 per picul, $131,815.
Net income, $106,815.
Interest, 75 per cent.

Afterwards the crop should be about 6,000,000 nuts annually—27,272 piculs of copra, at $5 per picul—$136,360. Giving a net income per annum of $111,360.
Dividend, 87 per cent.

NOTES ON THE ABOVE ESTIMATE.

In my opinion an island or peninsula is eminently suitable for coconut growing; either usually contains the essential condition as to soil, water, etc. Besides which they often offer the following special attractions:

(1) Light clearing.
(2) Small upkeep. The land not growing rank vegetation.
(3) Fencing small amount or none.
(4) Drainage little or none on account of the nature of the soil and the lay of the land.
(5) Little or no roading, the soil being sandy would allow of wagons being drawn over it at all seasons and the nuts might largely be collected by water.
(6) Probable exemption from disease, animals or thieves.

Against these advantages one must put the following:

(1) Purchase and upkeep of launch, boats, etc.
(2) Extra expenses in obtaining good fresh water.
(3) Possible extra cost of labor and things on account of isolation.

There are many advantages in running a proposition of this sort on a large scale. If, say, 6 blocks of 2,500 acres were taken up adjoining each other, this would allow of an oil mill being put up to good advantage. Large savings can be effected by the management. It allows of a thoroughly experienced planter being engaged as general manager, which is absolutely essential.

In these estimates I have reckoned on 40 palms to the acre, planting 30 by 30 will give 48. I have taken 220 nuts as making a picul of copra.

It will be noticed that in the above estimates Mr. Shaw Hellier allows for more than twice as many seed nuts as does Mr. Worcester—150,000 against 66,000; the former runs his rows about 9 by 9 meters (30 by 30 feet) while if the latter provides only 66,000 nuts for the 2,300 acres the rows would have to be about 12.2 by 12.2 meters (40 by 40 feet). In other words Mr. Shaw Hellier allows for 48 palms per acre against Mr. Worcester's 27—an increase of 77 per cent. In the writer's opinion the planter may take 120 trees per hectare (50 per acre) as the regulation number, though if he does not make a rather strong point of secondary crops in the young groves he may put as high as 65 or 70 trees per acre without crowding them for the first twenty-five years. If the planter finds that this quotum per acre is a little too much, the light-crop trees may be thinned out just as individual rubber and fruit trees are tapped to death or weeded out to make room for the more prolific individuals. In passing, we must recognize the fact that there are many groves in the Philippines with a stand of fully 500 trees per hectare (200 per acre) and we are forced to admit that at even *ten nuts per tree* on an average, the total crop may be in excess of that from a well spaced plantation yielding 80 to 100 nuts per tree; against the modern planter's protest of bad principle and short life of the old-style grove, the Filipino planter can offer the irrefutable argument of *little or no cost of upkeep and a comfortable income.*

While nearly every seed nut, if well selected, will give a tree worth planting, the wise superintendent will plant only *vigorous* seedlings; he will likewise have on hand a moderate quantity (say, 10 per cent) of stock in the nursery for "supplies" in case of the death of some of the plants at the time of transplanting; in other words, he will allow about 120 seed nuts for every 100 prospective palms in the grove.

Mr. Shaw Hellier allows for 220 nuts per picul[1] of copra, while Mr. Worcester allows for only 200. Both these estimates are too low, at least for nuts from the young trees; unless the trees are in an unusually vigorous condition and well spaced, the planter will do well to allow for 275 to 325 nuts per picul of well-dried copra; after long droughts as many as 500 and even more are required. Samoa and German East Africa reckon 7,000 nuts to the ton, or well over 400 to the picul; 6,000 is probably about the average for the world.

[1] A Philippine picul of copra weighs 139 pounds. About 16 piculs make 1 long ton.

The f. o. b. price per picul is at present about ₱12 ($6) for sun-dried and only about ₱1 less for ordinary (say, $85 per ton); at this rate the profits of both Messrs. Shaw Hellier's and Worcester's tables should be increased by 20 per cent. On the other hand, it is believed the estimates for the cost of clearing and cultivating in both sets of tables are somewhat too low.

For most plantations in the old districts of Laguna and Tayabas, except those on lake shore or seacoast, some ₱5,000 for the launch and its upkeep may be deducted from the first year's estimates. The amount for contingencies should be increased, likewise the amount for salaries, medicines, and tools.

A few more points regarding the gross-culture operations of the average plantation deserve attention here. The disposition of fallen leaves, dead fruit branches, etc., is one which the superintendent should settle for himself, i. e., as to burying, burning, composting, or hauling to the sea or river; but he should remember that all humus that can be put into a sandy field is a good improvement in the way of increasing the "sponge," or moisture-retaining ability of the soil, and that ashes are a fairly good potash fertilizer. The leaves should not be left to lie about on the surface of the ground under the trees; their leaflets, however, may be slashed off from the midrib with a sharp bolo, or cutlass, and these form a good mulch for the soil surface, yet at the same time are not liable to breed injurious insects. The heavy midribs of the leaves are a possible source of infestation since several species of small beetles may breed in them, some of which might eventually find their way to the living trees if they should ever "breed up" in very large numbers; therefore, it is well to burn the basal half or two-thirds of the midrib in heaps in the interspaces, the ashes therefrom to be immediately spread over the ground. In the case of poor soils it is advisable to bury the chopped-up midribs in shallow trenches, just covering them with earth; the gradual decay of this vegetable matter furnishes a considerable amount of humus which not only vitalizes a sandy soil, but "loosens up" a heavy clay; the planter must bear in mind, however, the danger from "uang."

The disposition of husks is another rather difficult matter unless the plantation is supplied with an artificial drying apparatus which utilizes them as fuel. Since it is manifestly impossible to bury all the husks, the following system is recommended: A shallow trench some 3 meters wide (say, 10 feet) is opened midway between two rows of coconut trees not far from the husking center; the husks are dumped into this shallow trench and piled up (concavities uppermost, so as to retain moisture and

hasten decay) to a height of, say, 1 meter above the soil surface; the earth from the trench is then thrown back on top of the heap, which, of course, extends gradually as the husks are dumped into it. If this heap can be conveniently covered by old leaves or trash, the decay is, of course, greatly hastened. The bottom of this crude compost heap will be pretty well rotted inside of a year, and the decayed-husk material forms a valuable manure for use about the young palms, both below and above the soil surface; it should always be mixed with earth to avoid grubs. By digging over the old heap the planter can have a constant supply of excellent humus for his nursery and for his young grove trees at practically no expense. The partially rotted husks may be left *in situ* for more complete decay at the first culling of the heap or they may all be removed at the same time using only the more pulverized portions for mixing with the soil around the young plants, and scattering the coarse pieces at random. The only fault in this method is due to the possible utilization of the husk heap in some districts by the female rhinoceros beetles as a breeding ground; however, since about one year is required for the development of the grubs, there is practically no danger from this source unless the planter leaves the compost undisturbed too long; by the same token, the heap may be used as bait to attract all the female "uang" in the neighborhood to the utter destruction of their offspring.

In plantations which do not utilize either husks or shells as fuel, the shells should be burned or broken up and the ashes or fragments spread evenly over the soil, especially about the young palms.

Precautions against fires must be taken at least in estates where cogon grass is left to flourish throughout the rainy season. For obvious reasons a dense stand of dry grass about young coconuts is a menace in the dry season. Several young groves in Luzon were severely damaged by grass fires in 1912. Broad belts of cadyos, cassava, ipel-ipel, or some evergreen shrub or tall herb should be maintained *without gaps* in cross rows (hollow-square system) every 100 to 200 meters through all uncultivated plantations.

Irrigation is extremely rare in coconut culture, but that is no proof that it would not pay. The coconut can endure droughts that would kill most other crops, but drought always predicates small and few nuts for the succeeding season. In many districts water could be turned on at slight expense.

In some locations the tuba industry is more important than copra making. This sap from the unopened flower buds of

SUN-DRYING COPRA SPREAD ON PALM-LEAF MATS.

(*a*) REMOVING HALF-DRIED "MEAT" FROM COCONUT SHELL.
Note steel spoon-shaped blade set in three-legged seat.

(*b*) REMOVING HALF-DRIED "MEAT" FROM COCONUT SHELL.
The position usually taken on tripod.

REMOVING COCONUT "MEAT" FROM SHELLS BY MEANS OF BURRS OPERATED BY TREADLES. COCONUT-OIL FACTORY, PAGSANJAN, LAGUNA.

BOILING GRATED COCONUT "MEAT" TO LOOSEN THE OIL CONTENT. COCONUT-OIL FACTORY, PAGSANJAN, LAGUNA

INTERIOR OF COCONUT-OIL FACTORY, PAGSANJAN, LAGUNA, SHOWING "POONAC," OR OIL CAKES, PALM-FIBER BAGS, AND WOODEN-SCREW PRESSES IN BACKGROUND.

GRINDING COCONUT CAKE FOR REPRESSING, COCONUT-OIL FACTORY, PAGSANJAN, LAGUNA.

This operation is repeated from four to six times; note heavy stone-weighted rocker with wooden jaws.

the coconut, or any similar palm, is a very palatable drink when fresh, and it contains, of course, a considerable percentage of sugar (about 12 per cent in perfectly fresh sap). Fermented, this drink becomes highly intoxicating and from the fermented article a distilled liquor (vino or arrack) is made. The present production of tuba appears to be decreasing, probably on account of the increased price of copra. In 1910 the annual production of tuba was reckoned at 175 million liters valued at 8½ million pesos, while in 1912 it was estimated to be only about 40 million liters, worth some 2 million pesos.

It is a question whether the tapping of a tree for tuba is a more severe tax upon its vitality than the production of nuts. So far as observed, there seems to be slight preference, other things being equal, in tapping young trees and in allowing old trees to produce fruits. Sugar may, of course, be produced from fresh tuba, but there would undoubtedly be a very severe loss to the coconut planter if he went beyond the wholesale production of fresh tuba, and that only when the local market indicated this rather reprehensible, though profitable enough, policy. The present production of tuba in the Philippines is about 40 million liters (say, 10 million gallons) per annum; at 5 centavos per liter this product is worth some 2 million pesos. One hundred and eighty liters is considered an average annual yield per palm; during six months the flow may amount to over 1 liter per day, but few trees can be tapped continuously.

Shredded coconut, while a splendid business in Ceylon, can not be recommended at present to the Philippine planter. The price of this manufactured article is considerably higher than that of copra, but the expensive machinery, comparatively limited demand, and difficulties of commercial handling, put this product out of the running, so to speak, with copra.

Oil may easily be made from either the fresh "meat" or copra. Though Manila now has a modern plant, most of the 4,800,000 or more liters per annum is turned out by crude apparatus (Plates XVII, XVIII and XIX). The principal difficulty heretofore in coconut-oil manufacture here for oversea trade seems to have been the heavy freights and expensive or imperfect containers; practically all the groves in the Islands of twenty years of age or over were originally set out to produce *tuba and oil*, copra being a new idea dating from about 1890. In point of fact, the planter who does not wish to invest a large sum in a machine-press oil plant and who, for some reason, does not choose to make copra, can do worse than follow the old hand method: treadle burrs to remove the "meat," caldrons to start the oil and re-

move the water, wooden plank presses on wooden screws, and a heavy rocker to regrind the press cakes; or, if he can not conscientiously waste the time and some 8 to 12 per cent oil in the cakes, he can compromise on a cheap hand hydraulic press which in two or three rapid pressings will leave in the cake only 4 or 5 per cent oil. Ten fresh nuts, worth about 25 centavos, make a liter of oil worth 30 centavos. This oil, stored in large earthenware jars keeps well, *even in rainy weather*—which can not be said of ordinary copra.

The coir industry may in the near future become of considerable importance here; at present, however, there is practically none produced, and so long as tropical America continues to send vast quantities of nuts in the husk to American and European markets, there will be only a precarious trade in Philippine coconut fiber. At present the only use made of the husk fiber in the Philippines is as a substitute for oakum in calking boats and ships. In Java, however, the coir industry is assuming considerable prominence. On a modern estate a coir plant could well be run in connection with the drying house, steam from the boiler being used to run the machinery for stripping the husks; all refuse would find its way into the furnace of the drying-plant boiler.

VARIETIES OF COCONUTS.

Throughout the coconut plantations of the world, there appear to be only two or three varieties under general cultivation, and these are so closely alike that the ordinary observer fails to note any differences.

The exact number of forms and varieties of the species (*Cocos nucifera*) can never be known till they are all "tried out" side by side, but there are probably in the vicinity of twenty-five; of these not more than ten are sufficiently common to be worthy of mention as economic varieties.

Besides the ubiquitous *Green* and *Yellow* forms of the plantations—these two being distinguishable merely by the color of the midrib of the leaf and the shade of the immature nut—the *Pemba* probably deserves first rank. This variety seems to be native to the Island of Pemba in the British protectorate of Zanzibar off the coast of East Africa. The tree is comparatively small, though the writer has noted 15-meter specimens in the Zambesi Valley. It is exceedingly prolific. The husk is of a distinctly pale-yellow color with a more or less shining surface and without the prominent angles of the common sorts; the husk is comparatively thin while the "meat" itself is of ordinary thick-

ness; in other words, the percentage of "meat" is very high in the total weight of the nut. There are but very few trees of this variety now in the Philippines. A similar, larger-fruited sort seems to be native here, but is exceedingly rare.

One of the most striking varieties in the Philippine plantations is the *Guinaring,* or *Ivory;* this appears to exist in two forms, one nearly globose, the other considerably elongated and with rather prominent angles. The color is a pale yellowish white, this feature rendering the tree distinguishable at some little distance. The nut itself is not quite up to the standard as to the thickness of meat, flavor, oil content, etc.

The *Kalimbahim,* or *Pink-husk,* resembles the ordinary *Yellow* as to habit but has the interior of the husk rose-colored.

The *Dwarf,* or *Dahili* (or *Mangipud*) nut appears to be more or less common throughout the Archipelago and from its habit of early maturity and apparent prolificness, it is recommended as a variety for planting in town yards, public squares, etc. Besides this there is still another rare form of dwarf coconut which yields a large number of very small nuts, some of them not more than 6 to 8 centimeters (2 to 3 inches) in diameter when husked. It is questionable whether the giant nuts of Lingayen Gulf (in Pangasinan Province) and San Ramon Farm (Moro Province) are anything more than vigorous strains of the common *Green* or *Yellow;* but the chances are that a nut of this type planted in a nursery with others would not only develop a stronger seedling but the plant itself would tend to show the character of the parent, even under adverse conditions. The planting of these giant nuts is not advisable, however, for the total weight of the yield per tree is probably no higher than in the case of the ordinary sorts; less than 200 of these nuts it is said are required to make a picul of copra.

The *Edible-husk* nut, or *Tagnanum,* of India and of the Philippines is so strikingly different from the common types that it might well be regarded as a subspecies. The value of this variety, however, is more in the line of a curiosity than as an economic. The unripe husk is more or less saturated with a sweet sap carrying a small amount of astringent substance.

The *Macapunó* is rather a sport, or freak, nut than a distinct variety. There is no question but that the average Filipino coconut grower can readily distinguish by "weighing" in the hand these nuts from others in the pile. Furthermore, it is certain that the coconut pickers know from experience which trees in a grove usually produce these nuts. Its remarkable character consists in the cavity being more or less completely filled with

"meat." This abnormal kernel, strictly speaking, has nothing to do with the spongy mass of the "embryo foot," or special organ which transforms the albuminoid substance of the kernel into soluble plant nourishment for the use of the sprouting shoot. (Plate II.) The *Macapunó* apparently has a tendency to ferment if kept for any considerable time. This quality of the pulp is decidedly superior for making "dulces," or desserts, since it lacks the tough fibrous texture of the ordinary kernel. It is probable that a genuine *Macapunó* could never germinate, though, by the same token, it is possible that a tree grown from a normal nut of a *"Macapunó tree"* would be very liable to show that sport.

About twenty "named varieties" are known in Malaysia; Ceylon, the Maldives, Laccadives, Andamans, and the Malabar Coast are said to evidence some 30 sorts. A "try-out" test side by side of all varieties would form a very interesting and important experiment.

There is a common belief that the "meat" from certain trees is sweeter and tenderer than that from others; this probably is true in a measure, but it is a question whether the nuts from a "good-eating" tree can be depended upon to reproduce true to the parent type.

In passing, it may be remarked as a strange fact that a plant, which has been cultivated for at least several thousand years and which is to-day one of the most indispensable plants in the world, should not have run into more numerous varieties. Originating, it is believed, in the mountainous regions of Central Colombia in northern South America, carried westward across the Pacific long before the dawn of civilization, and now grown more or less extensively in every frostless maritime region of the world where droughts are not too inimical, this species has kept remarkably free from sports and modifications. The genus *cocos* is a large one, but without exception all the species, except the domesticated *C. nucifera,* are confined to the American Tropics. (On a par with the coconut as to peculiar origin and distribution may be compared the banana; though the latter is pretty certainly a species of more recent domestication, there are probably upwards of 100 distinct varieties of the species known as *Musa sapientum,* with as many more of the very closely related *M. paradisiaca,* besides dozens more of the three or four similar species.)

One other feature should be borne in mind in regard to the distribution of the coconut; it appears from data gathered by Dr. O. F. Cook, of the United States Department of Agriculture, Washington, D. C., that this plant is absolutely dependent upon

man for its distribution; that is, the nuts do not, as was formerly believed, germinate after having been floating in sea water for a long time, as would be necessary in traveling in ocean currents from one country to another. The sponginess of the husk, therefore, is not for the sake of buoyancy in water, but is actually a padding material to break the force of the shock in falling from the crown of the tree.

With the exception of the *Dwarfs*, the life of all varieties is indefinite; like its distant relative, the date, the coconut lives on fifty, seventy-five or a hundred years, till some physical trouble breaks down its "iron constitution" and ends a life of usefulness hardly to be equaled by any other plant in the world.

HARVESTING.

When thoroughly ripe, the nuts will fall of their own accord, sometimes singly, sometimes in whole bunches; in the fall, except from very high trees and on clayey ground, there is not much danger of the inner shell being fractured. In Samoa, in accordance with law, only these fallen nuts may be gathered for copra; the common method in the Philippines, however, is picking, either by means of a bamboo pole bearing a knife at the tip, or by a short knife in the hands of a laborer who climbs the trunk. There are some advantages with the pole over letting the nuts fall of their own accord; in protected localities where wind has little effect on the ripe fruit bunches, the nuts may adhere to the fruit branch so long after becoming fully mature that either germination or a kind of fermentation may set up inside the nut, and this, of course, is exceedingly injurious to the "meat." On the other hand, however, it insures absolute ripening of the nut, a very important matter in the Philippines, a deplorably large percentage of the nuts harvested here being decidedly too green for the maximum of oil to be obtained.

There is no great objection to the use of the bamboo-pole knife, especially in the case of trees less than 8 meters high. An expert laborer can select the ripe nuts from a certain cluster and leave those at the tip somewhat longer if he chooses. The tendency, however, is to remove the entire cluster, ripe and half-ripe, at one picking. Climbing is, of course, a laborious and somewhat dangerous operation in the case of very tall trees, but it always gives the picker a chance to clean the crown of the tree, i. e., to remove all dead leaf-bases, old fruit branches, and the "strainer cloth," or mass of fibrous substance which accumulates around the leaf-bases and which furnishes a nest for rats, ants, etc.; it also allows the picker to select at close range the nuts in

each cluster so that no immature ones may be harvested. Burning the fiber and loose trash in the crown at each picking is sometimes recommended, especially where ants or rats are very troublesome; it does not seem to harm the tree, aside from blasting a few flowers and very young nuts.

The Filipino pickers do not use an ankle ring nor waist rope (as do those of some other countries) to assist in climbing the trunk (Plate V); skill in using the old leaf scars for footholds enables these pickers to *walk up* a tall trunk in less than a minute; the small diameter of most Philippine coconuts facilitates this simple method; the huge boles of western Porto Rico, sometimes nearly a meter in diameter (*thrice* that of the ordinary palm here), could not be managed thus.

Steps should not be cut in the trunk; slightly notching the bole renders climbing much more easy, of course, but it endangers the vitality of the tree in more ways than one. Even in the case of tuba trees where one or two visits to the crown must be made daily, only a very few ladder trees in a group are required since it is possible to fix a couple of bamboo poles from one tree crown on to the next, so that the tuba gatherer walks across on these bridge-and-rail aerial ways, descending only at the end of the route. (Plate VIII.)

Seed nuts should be lowered to the ground with a cord, to avoid any chance of cracking the shells or injuring the "eyes."

The removal of the nuts from tree to husking pile may be done, according to the kind of plantation, with anything from a carabao-sled to an auto-truck, or by the still better tramway. On large estates where the soil is loose and the ground more or less level, there is not much question but that a narrow-gauge tram line, laid from the drying house to the few or many loading stations back in the grove is a money-saving feature. The nuts may be brought from the trees to these stations either in large baskets carried by two men or in small bamboo sleds drawn by bullocks or carabao, and from these small heaps the tramcars—which should, of course have bamboo racks—take the nuts to the factory, either carabaos, bullocks, or the pickers themselves furnishing the locomotive power.

The nuts should not be thrown about more than necessary since the sharp jar of one nut striking another is liable to slightly crack the shell, an injury which may not be noticed at the moment and so the cracked nut may happen to get placed with the others in the curing racks, which means, of course, that it soon becomes a total loss.

Where river, estero, or even salt-water transportation is

practicable, any of these means of transportation may be used for getting the nuts to the factory. In short, the transportation of nuts in bulk is a matter for the superintendent himself to decide.

The curing process is really a part of the harvesting operation. As explained in the chapter on seed management, the full oil content of the nut is not developed until a considerable period has passed beyond the actual or botanical maturity of the nut. In the case of nuts being allowed to fall of their own accord, there is no necessity for the curing bin, but where nuts are picked promiscuously by careless laborers and especially in the estates wherein managers allow even green-husked nuts to be picked (estates which are exceedingly numerous in the Philippines), a sort of drying or curing rack for such nuts is necessary. At least two and better three or four weeks of curing is advisable before breaking. The curing rack should be made of bamboo or palm strips widely spaced in laying so as to admit free circulation of air up through the mass of nuts; it should have a side wall or railing to retain the nuts which may be piled in fully half a meter deep. The floor should be at least 50 centimeters, or probably better 75 centimeters (say, 2 feet), above the ground. The racks may be made lengthwise between rows of palms so that the freshly picked nuts will be added at one end while the cured ones are being broken at the other—in case there are only one or two racks, as on a small estate.

If properly shaded, the nuts may be husked at any time after picking during the curing process, but unhusked nuts should not be left exposed to full sunshine since the oily interior might thereby become rancid. It must be remembered, however, that husked nuts are much more liable to become cracked by rough handling, while on the other hand nuts cracked in picking or bringing to the factory might be found and saved if they were husked immediately, whereas they would be lost if allowed to remain with the others in the curing rack. It goes without saying that all nuts, husked or unhusked, showing the slightest trace of a leakage must be opened at once, since bacteria can easily enter, 100 abreast, through an apparently minute crack in the shell.

The frequency of pickings depends largely upon the condition of the trees. While the crop is naturally continuous with little or no variation as to the number of nuts produced in any given month of the year provided there is no prolonged dry season, there is a tendency, on plantations which are not provided with modern drying apparatus, to leave as many as possible during the

rainy season and to over-pick at the end of the dry season. On some of the best plantations in the world thorough pickings (20 to 50 nuts per tree) are made every eight or ten weeks. To pick oftener than every eight weeks would in most groves mean the picking of some unripe nuts or at least the expenditure of an undue amount of labor per nut picked.

While there are several machines now on the market that are supposed to more or less economically remove the husks, it is probable that 99 per cent of the coconuts of the world will be, for some years to come, husked by hand. The use of a special sharp-pointed steel shoe, thick-edged knife, or plow-point in the hands of a skilled laborer, is good enough for the average plantation. There is great difference in the ease with which nuts are husked, depending, of course, upon the size, variety, state of maturity, and dryness of fiber, but a good laborer should husk at least 1,500 nuts per day and an expert working by the piece may husk over 3,000—six to eight per minute. In this connection, it would seem that the Filipino husker excels all others. (Plate XI.) If the superintendent wishes to keep separate the "meat," from the germinating, unripe, cracked, or second-class nuts, the husker can very readily sort them out and throw them into separate heaps with practically no waste of time.

Breaking is a very simple operation—one or two short sharp blows with a heavy dull knife on the equator, so to speak, of the nut (held in the hand); one laborer is able to break for three to five huskers. The breaker himself may make the assortment of the different grades of nuts according to the quality of the "meat" exposed when opening the shells. (There is a greater reason for this sorting than most people realize.)

Breaking should be done over a concrete floor sloping to one side or the center, from which a drain carries the "water" to some convenient pit or water-course. In a few instances this "water," which, of course, contains a small amount of albuminoid food material, is saved and fed to pigs, mixed with some dry matter like tiqui-tiqui (rice bran) or poonac (copra cake). It is said to be possible to practically maintain a pig on this liquid alone, though it is a question if any animal could ever be fattened upon it.

Where there is plenty of drying space for the "sun" method, the nuts need not be husked; two good blows with a cleaver or broadax will lay open the halves which are then put out to dry so that after a few hours the incurling "meat" is readily removed with the hardwood or steel knife. The two halves of the

chopped-open unhusked nut may be tied together (by their loose coir strands) and slung on lines of bamboo poles supported a little distance off the ground, thus avoiding the "sanding" evil and utilizing any wind movement to hasten the drying.

DRYING THE COPRA.

Of the approximately 1,750 tons of copra which the world is now consuming each day, it is probable that only 1 or 2 per cent of this amount is clean, white, dry product. Probably something like one-half is sun-dried, while the remainder is put through some sort of kiln and more or less smoked and burned in the process. Here in the Philippines very little copra outside of the Visayas is sun-dried. (Plate XIV.) The remainder is partially dried over the tapahan, or "parilla" (Plate XII), the Philippine type of drying apparatus which consists essentially of a more or less elevated latticework flooring over a partially sunken fire-box or furnace. The sun-drying method requires from two to four days of "good sun;" the kiln takes one to three; and the oven from eight to twenty hours, depending on temperature and type; the rotary type is said to turn out a finished product in less than five hours.

Instead of great care being used in the matter of fuel as is done in Ceylon and Malaysia, the Filipino planter is likely to use not only the shells, thrown into the tapahan furnace in heaps, but even husks, many of which are not by any means dry. This fuel results in an undue amount of smoke which thoroughly impregnates the "coprax," or pieces of "meat," which are spread at varying depths upon the latticework over the furnace. This smoking evil could very easily be prevented by the mere slipping of a broad, thin sheet of galvanized iron or other metal just under the latticework while the smoke from the charge of fuel is passing off, removing this, of course, as soon as a good bed of coals is obtained; the expense for such an obvious improvement would be quite insignificant, but the breaking away from a time-honored custom is somehow a difficult thing to do.

Smoked copra would not be so bad provided it were to be used only in soap-making or other crude purposes, and provided the drying was *even* throughout the pile over the furnace; as a matter of fact, practically all tapahan copra of the Philippines is imperfectly dried and frequently reaches Manila in a stinking, half-rotten condition; here it may be partly redried, if time permits, either in the sun or by some artificial means, just previous to shipping. Considering the fact, however, that in each bag there is likely to be a considerable percentage of burned pieces

and a good deal of half-dried material, it is no wonder that the copra, as it enters the European market, is in a shameful state. The moisture content of Manila copra runs from 9 to 18 per cent; it should be below 10 per cent to ensure its good keeping qualities en route to the manufacturer. The oil content, by weight, of good copra should be from 60 to 68 per cent.

If kept cool, dry, and away from the light the natural acids (lauric, capric, caproic, and caprylic) in coconut oil are nearly stable and harmless; but in the presence of moisture these oxidize and break up into numerous other acids and glycerides, or in other words the product becomes rancid. If the producer, middle-man, and shipper would only realize that rancid copra means a loss of oil content (formation of acids) and that every little spot of mold shows where a few drops of good oil have been consumed by the fungus—lost forever, and no one the gainer—they might combine somehow to give the consumer a better article and save a few million pesos per annum for themselves. After all is said, the Philippine coconut grower is not very much to blame for this gross malpractice, for the reason that the copra buyer refuses to bother about standard grades or anything of the sort and frequently, for some unknown reason, offers the producer about the same price for third or fourth class material as for good, clean, white product; the question is of quantity, not quality.

It is apparently only a matter of a few years now, however, when this commercial whim must be set aside. Europe alone is now said to be consuming about 1,000 tons of copra per day (fully one-half the total output) in the manufacture of food products. This copra-food idea is rapidly growing, it seems, not only in Europe but in America; not only in the manufacture of vegetable butters but combined with other substances and treated by various processes, both the solid and the liquid portions of copra oil become the principal ingredients in many cooking oils, margarines, etc. In price these can readily compete with any other vegetable oil stocks, not excepting cottonseed products. In this connection may be mentioned an interesting feature of the coconut-oil food business. The Financial Times prints the following paragraph which indicates the status of the matter in Asia:

> A point to notice is that the entire absence of animal matter from this article enables it to be used among Mohammedans, Jews, and Buddhists, without offense to their religious beliefs; this is a very important matter, as is shown by the recent figures of consumption relating to the Far East, which demonstrates that vegetable butter is commencing to occupy a prominent position in the diet of the Asiatics.

Still another point is that the bacilli of tuberculosis have (rarely, it is true) been found in "pure dairy butter." Such facts as this coupled with the lower price and excellent keeping qualities help to influence the average housewife toward the habit of using coconut butters instead of the animal products.

At present in the United States there are only a few factories for the manufacture of coconut oils, suets, and butters, but there will soon spring up, especially on the Pacific coast and, as soon as the Panama Canal is opened, on the Atlantic and Gulf coasts, numerous plants for handling Oriental and Pacific copra.

Poonac, or copra cake, is one of the best feedstuffs for domestic animals that has ever appeared in the world's markets. It is such a staple in Europe that the copra dealers there can well afford to encourage bulk shipments of the raw product instead of the pure oil, no matter how great the distance. By the same token, it is only natural that the poonac and wholesale copra merchants should oppose the local manufacture of coconut oil. The time is not far distant, however, when many of the Philippine coconut planters will make their own oil, ship it through middlemen or direct, and utilize the cake in feeding pigs, cattle, and poultry; this will be the highest economy possible. Manila already has one large up-to-date copra-oil plant and it is expected others will soon follow.

The new style hydraulic presses leave only about 2 per cent of oil in the cake, which makes it of more value as a fertilizer than a cattle feed; ordinarily from 4 to 6 per cent of oil is left.

In this connection it is of interest to note that sending the oil off the estate does not abstract any plant-food elements therefrom, no more than the export of sugar does; and keeping the solid portion of the coconut kernel (poonac) which still carries from 4 to 8 per cent of oil, feeding it to live stock, and using the composted manure around the palms is saving the rather small leakage which occurs through copra output. (Neither copra, oil, nor sugar, if pure, contain any ash whatever, being composed of "gaseous elements" only.)

As an evidence of the flexibility, so to speak, of the coconut crop, may be mentioned the case of Ceylon's yearly output; some 500 million nuts are consumed fresh—which would equal 80,000 tons of copra; 27,000 tons of oil, 22,000 tons of copra, 10,000 tons of "dessicated coconut," and some 5 million liters of arrack (spirit from the fermented sap)—besides vast quantities of fresh tuba and coir fiber—are produced. The least change in the market price for any one of these articles influences the output of all the others.

The world's markets are hungry for good copra; the demand for the A-1 dry, unsmoked, nonmoldy staple will increase and while the supply is increasing rather rapidly, it is believed that the price has not yet reached the high-water mark; as soon as the first-class grade is obtainable in fair quantities, however, the price of the low grades will have to drop considerably. Therefore it behooves the Philippine planter to lose no time in improving his methods of drying so that in the near future the dealers can list him and favor him as a clean-copra producer. At present the sad fact is that the Philippine copra is about the worst (with the possible exception of some Pacific and most of the Indo-Chinese article) in all the world, at least according to market quotations.

While there are, of course, several distinct types of smokeless driers now on the market, the two which will probably supersede all others are the steam-pipe-hot-oven and the forced-draft-hot-air types. These apparatus may be made in a great variety of styles. The underlying principle in the former is a simple steam boiler having a large fire box (to accommodate husks, shells, or other kind of bulky fuel) connected to an oven filled with sliding trays and one or several tiers of steam pipes; this drier costs very little for operation, the husks and the shells furnishing a superabundance of fuel, the steam pressure being low, and there are no bearings to wear out. The bottoms of the trays, which may be made of any convenient size, should be of bamboo latticework or of galvanized-wire screen; no iron should be used on account of its blackening effect on the "meat" coming in contact with it. The oven itself may be made of any light wood and no special care is needed in its construction. The cool air enters around and beneath the trays in the lower portion of the oven, while the hot moist air from the copra rushes out at the top. (Plate XIII.)

A temperature of 50° to 70° C. (say, 120° to 160° F.) is sufficient to thoroughly dry copra in this oven in fourteen to eighteen hours; above 75° C. (170° F.), there is some danger of scorching or rather browning the material in the trays, even if they are made (as they should be) of split bamboo or light wood. This machine, however, may be and is misused. The copra can be removed *in eight hours* and sold on a par with the tapahan article, which it excels only in point of being unsmoked and evenly dried.

In passing it may be mentioned that there seems to exist a belief among the planters and copra dealers in Ceylon to the effect that any high temperature is liable to volatilize a portion

of the oil in the "meat." While it is true that many oils are in a measure volatile at ordinary and oxidizable at high temperatures, those of the coconut type are practically stable. The real trouble behind a copra dealer's being afraid of "machine-made" copra is based upon the fact that, bulk for bulk, such copra is, of course, considerably lighter than that made by either the sun-dyring or kiln process; being accustomed to a heavy article the dealer naturally jumps to the conclusion that if it requires more nuts to fill a full weight picul sack with "machine-made" copra, there has been a loss of oil and not merely one of water. Until the dealers, then, can prove that bulk for bulk the artificially dried copra contains less oil than the ordinary article, the copra maker should put down all adverse criticisms—which occur in practically every new feature of any industry—as being due to an instinctive prejudice against anything which upsets the old and familiar scheme of things.

On large estates, the construction of a spacious drying house is recommended; this may contain three to six floors which should be constructed of bamboo or palm latticework. From one or more large furnaces just outside this building hot dry air is drawn into the interior and forced up through the several layers of copra, a tall chimney giving a strong draft to accelerate the evaporation. If carefully managed, there should be no danger of scorching any of the material, even on the lower floors, since only a comparatively low temperature is required, provided the current of air is strong. Such a system naturally requires considerable more time than the steam-pipe-hot-oven apparatus, but this is a secondary consideration where very large quantities of the raw product are to be handled; from one to two full days (night shifts required) should suffice to thoroughly dry the copra. The disadvantages of this system are: The ventilating fans require considerable power which could not very conveniently be obtained direct from the furnaces; the bringing in of the raw "meat" and the taking out of the cured product require mechanical conveyors of some sort; the removal of the copra on any given floor which may become dry before that on a higher or lower floor would be difficult since it would not be very pleasant for laborers to work inside the building while the hot air was turned on—yet even this could not be much worse than the smoke of the tapahan dry-house.

The public and the trade, then, must know that the clean, unsmoked copra is not only worth more *per se* than either the sand-covered sun-dried or the rotting kiln-dried stuff, but the artificially dried product can be kept in the bodega for several

months if the producer desires to hold it on any question of price or weather.

The accompanying graph indicates the annual copra export in comparison with the average export price per picul for the years 1899 to 1912.

GENERAL MANAGEMENT.

Only a very few principles can be laid down for general application on the various kinds and sizes of plantations. Broadly

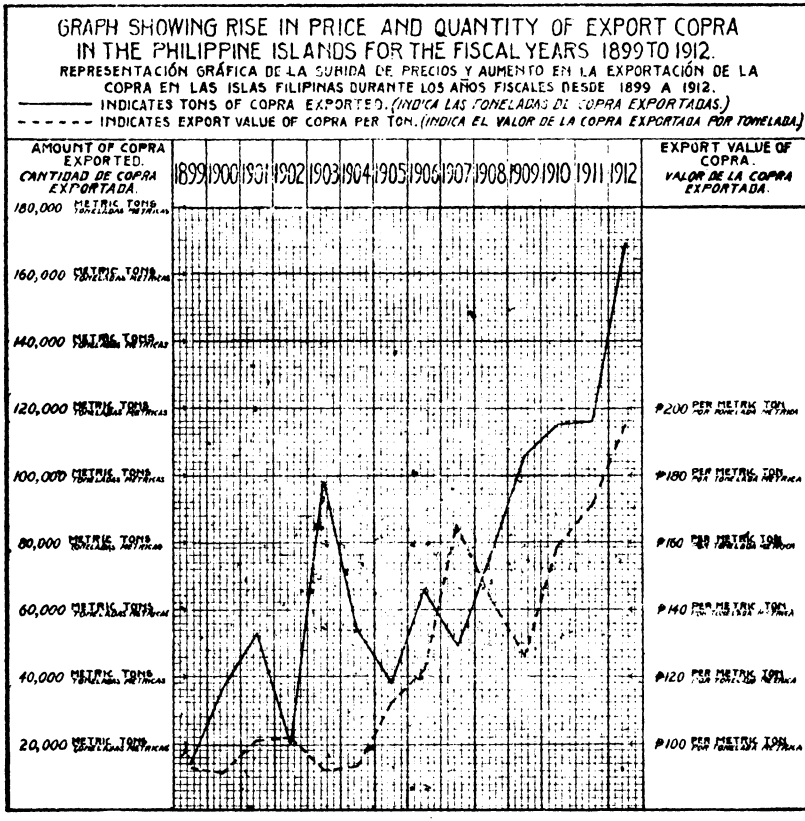


Fig. 2.

considered, a model coconut plantation should comprise at least 200 hectares (say, 500 acres). A coconut grove of this or larger dimensions should have a staff composed of a superintendent and assistant superintendent, both of whom should reside, and one of whom should always be on duty, on the estate; from one to three "capataces," or overseers; one man to care for the animals—it being supposed that either carabaos or bullocks are used in considerable numbers on the estate, and, if secondary

crops are handled, mules or even horses may be required; one carpenter and joiner with an assistant, who should have charge of the construction and repair of all hauling vehicles, storehouses, outbuildings, and, if certain labor systems are employed, the erection of laborers' huts; a blacksmith and helper, who should also assist in the construction and repair of carts, etc., and, if a tramway is laid down, in the repair of all materials concerned therewith; depending upon the degree of cultivation given and the kind of cover and secondary crops used, some 15 to 25 laborers (say, one man to every 1,000 trees) at 50 to 75 centavos per day should be constantly employed. In case an artificial drier is installed, which, of course, is to be presumed, the staff should be increased by the addition of one engineer, one assistant engineer, one copra overseer and some 5 to 10 laborers to attend to the drying. Reverting to figures, let us say that the 200-hectare plantation has 20,000 trees; these should yield nearly 2 million nuts per annum, which should return some 6,000 to 8,000 piculs of copra; at this rate the dry-house must turn out 20 to 25 piculs (or between 1¼ and 1½ tons) every working day. The daily running expense should be less than ₱40 and the cash value of the output ought to be well over ₱200. On larger estates the ratio between the expenses and returns is, of course, still much more favorable to the "net profits."

In this connection it should be mentioned that if a large central drying plant is established in a locality, it may be advisable for the planter to deliver his raw product to the central factory instead of installing a plant of his own.

While only two or at the most three varieties of coconuts are recommended for the average plantation in the Philippines, the up-to-date proprietor should carry on a series of experiments in order to test new varieties from other countries, various methods of cultivation, fertilizers, etc., so that he can at first hand get a clear conception of the whole coconut question considered agronomically.

Practically all of the laborers' food, with the exception of rice, should be produced on the estate, as explained in the chapter on secondary crops; both the grain and root crops can be grown with a slight extra expenditure in the new blocks, i. e., between the rows of trees less than six or eight years of age. Besides, on every large estate, there should be a spacious garden from which ample quantities of fresh vegetables may be had throughout the year. In connection with this garden there should also be an experimental field for testing cover crops, new food crops, fruit trees, legumes, etc., all of the information gained

therein being good grist for the expert judgment which the planter will acquire only after experience.

On large estates there ought also to be an animal husbandryman who should have some veterinary knowledge; he will look after the breeding not only of the carabaos and bullocks for traction purposes, but also the saddle horses (of which quite a number will be required for the use of the superintendents and overseers) and pigs, of which there should be enough to consume all the waste roots, maize, and other grains, and, of course, poonac, in case oil is made on the estate. A good-sized flock of goats costs very little for maintenance and furnishes a supply of excellent meat which is not always forthcoming in isolated estates. African fat-tailed sheep are a new introduction of merit. In connection with pig feeding, it should be borne in mind that the copra cake is rather too heavy and rich to be fed unmixed with some roughage, though it could well be used to give a little body to the "water" from the breaking bed; the price of pigs, either live weight or dressed, is comparatively high and the sale of the surplus animals should bring in a handsome revenue.

Poultry should also be in evidence; a large flock should be maintained, preferably in a wire-fence enclosure. Chickens are exceedingly fond of coconut "meat," especially when fresh; refuse maize and other grains may also be utilized.

A compost pit should be a prominent feature among the outbuildings. This pit should be constructed of cement-lined brick or concrete, should have two bins or reservoirs, a galvanized-iron roof, and wire-screened doors and ventilators. Into this pit goes all the animal manure, vegetable refuse, weeds, etc., and more or less earth and after a few weeks of fermenting and rapid decay, the composted plant food may be removed and used, without fear of souring the soil and with the knowledge that this is the best sort of natural fertilizer to stimulate rapid growth and make for big yields in young or, for that matter, old coconuts. A model pit of this type (designed by the writer and constructed by the chief of the division of machinery and construction) may be seen at the Bureau of Agriculture stock farm at Alabang, Rizal.

It is a question for the superintendent of an estate to decide whether labor shall be entirely of the "day" kind or whether a certain amount of "piece" labor will be most economical. It is believed that carefully inspected piece labor will give the best results on the superintendent's books. The writer prefers to go even a bit farther and allow each laborer a certain bonus or percentage, however small it may be, out of the net

profits of the estate; this forcibly reminds the laborer, of whatever grade he may be, that he has a real personal interest in the management and success of the plantation and there is no question but that on general principles, at least with similar lines of work, this policy prevents a certain amount of shirking which can hardly otherwise be avoided, and imparts an *esprit de corps* that can be maintained in no other way.

A store, or commissary, should be in evidence on every large estate. This not only allows the laborers and superintendence staff to procure the ordinary necessities at a fair price without leaving the place but, if well managed, it also brings in a fair revenue to the estate.

A dispensary is also a good institution for the modern estate. Medicines and dressings may seem expensive but they may also save many times their cost in "labor hour units" and, on island plantations for instance, far removed from good hospitals and physicians, they *must be kept on hand.* The large estate requires a doctor.

Chemical manures, while not necessary, especially if the estate has a compost-pit, are probably economical when used in moderation. Nitrogen fertilizers are, of course, indicated for young trees, and potash and phosphates for bearing groves.

SUMMARY.

Coconuts have been planted in the Philippines for scores of years but until about 1890 they were grown very largely for oil and tuba, a comparatively small number being consumed here in the fresh state as food.

About ten years ago the great importance of copra as a commercial staple began to be realized and crude methods for its preparation were instituted, especially in Cebu, Albay, Leyte, Samar, Tayabas, and Laguna. The old groves were planted in a more or less haphazard manner, the denseness of the stand of trees being very excessive, some 250 to 500 trees per hectare instead of 100 or 150 being the rule. Recently, however, the faults of this error have been realized and, generally speaking, the young groves are very much better laid out and more properly managed.

Although the crowding of the trees has been an obvious mistake and the lack of cultivation has very seriously delayed the maturity of the young trees as well as affected the prolificness of the old trees, there has been an undeniable profit realized from even the worst plantations. With this fact as a starting point the coconut planter in the Philippines may with good reason

look forward to far greater profits if he will only apply the common principles of agriculture, bearing in mind the comparatively few special requirements of the coconut.

At present in the Philippines the coconut is comparatively free from insect pests and fungus diseases; the rhinoceros beetle is, however, more or less common throughout the Archipelago and in most locations adjacent to forested areas wild pigs and deer are usually found in such numbers that young groves unless fenced are liable to be severely damaged.

On plantations in which the trees are properly spaced secondary or catch crops may be planted to very good advantage for the first ten years or so. These catch crops serve both to benefit the soil and to furnish food for local consumption. Cover crops for keeping down weeds and grass may also be used in many cases to reduce expenses of cultivation and at the same time to furnish nitrogen to the soil.

Transportation of both raw and finished product is necessarily somewhat expensive but if the plantation is located near a harbor, navigable river, or railway line, and if light tram lines are used through the plantation, there should be no serious difficulty in this line.

Most of the Philippine copra is at present partially dried over a tapahan, or kiln. A considerable quantity, however, especially in the Visayas, is sundried, this method producing a higher-priced article and one which has the advantage of containing no creosote as does the smoky product from the tapahan. Artificial driers are coming into use and it is believed the general adoption of this method will very greatly improve the status of the Philippine copra market. Philippine copra now ranks very low as compared with that product from other countries, due largely to the faulty methods of preparation. About one-fourth of the world's copra is, however, produced here. The industry is increasing rapidly, the copra exports for 1912 being 46 per cent greater than in 1911 (fiscal year).

The labor supply for coconut planting is in most provinces fairly abundant and the wage rate is not high as compared with other crops.

There is plenty of available land for coconut planting, not only in Mindanao and the southern islands—which region is to be preferred perhaps—but also in the western Visayas, in the Albay Peninsula, and in Tayabas. There is still some available land in the Province of Laguna but the best sites have already been occupied there. Excellent coconuts are grown about the Gulf of Lingayen, and there is still considerable ground in this

section suitable for the crop. Mindoro Island also offers large suitable areas. Land may be leased or purchased from the Philippine Government at very low rates.

The outlook for high prices for copra, coconut oil, and fresh nuts in the Philippines is good. The returns, with careful management, should, at the end of the ninth year, be enough to pay for the "bringing in" of the plantation, and dividends ranging from 10 to 75 per cent according to local conditions and management may be expected from the tenth to the hundredth year.

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